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ARTICLE VI.—*On some points in American Geology.* By T. STERRY HUNT, F.R.S., of the Geological Survey of Canada.

(*From the American Journal of Science No.* 93, 1861.)

The recent publication of two important volumes on American geology seems to afford a fitting occasion for reviewing some questions connected with the progress of geological science, and with the history of the older rock formations of North America. The first of these works is the third volume of the Palæontology of New York by James Hall; we shall not attempt the task of noticing the continuation of this author's labors in the study of organic remains, labors which have by common consent placed him at the head of American palæontologists, but we have to call attention to the introduction to this 3rd volume, where in about a hundred pages Mr. Hall gives us a clear and admirable summary of the principal facts in the geology of the United States and Canada, followed by some theoretical notions on the formation of mountain chains, metamorphism and volcanic phenomena, where these questions are discussed from a point of view which we conceive to be of the greatest importance for the future of geological science. A publication of this introduction in a separate form, with some additions, would we think be most acceptable to the scientific public.

The other work before us is Prof. H. D. Rogers' elaborate report on the geology of Pennsylvania, giving the results of the Survey of that State for many years carried on under his direction, and embracing a minute description of those grand exhibitions of structural geology, which have rendered that State classic ground for the student. The volumes are copiously illustrated with maps, sections and figures of organic remains, and the admirable studies on the coal fields of Pennsylvania and Great Britain add much to its value.

The oldest series of rocks known in America is that which has been investigated by the officers of the Geological Survey of Canada, and by them designated the Laurentian system. It is now several years since we suggested that these rocks are the equivalents of the oldest crystalline strata of western Scotland and Scandinavia.* This identity has since been established by Sir R. I. Murchison in his late remarkable researches in the north-western Highlands, and he has adopted the name of the Laurentian system for these ancient rocks of Ross, Sutherland, and the Western Islands, which he at first called fundamental gneiss.† These are undoubtedly the oldest known strata of the earth's crust, and therefore offer peculiar interest to the geologist. As displayed in the Laurentide and Adirondack mountains, they exhibit a volume which has been estimated by Sir William Logan to be equal to the whole palæozoic series of North America in its greatest development. The Laurentian series consists of gneiss, generally granitoid, with great beds of quartzite, sometimes conglomerate, and three or more limestone formations, (one 1000 feet in thickness) associated with dolomites, serpentines, plumbago, and iron ores. In the upper portion of the series an extensive formation of rocks, consisting chiefly of basic feldspars without quartz and with more or less pyroxene, is met with. The peculiar characters of these latter strata, not less than the absence of argillites and talcose and chloritic schists, conjoined with various other mineralogical characteristics seem to distinguish the Laurentian series throughout its whole extent, so far as yet studied, from any other system of crystalline strata. It appears not improbable that future researches will enable us to divide this series of rocks into two or more distinct systems.

* Esquisse Géologique du Canada, 1855, p. 17.

† Quar. Journal Geol. Society, vol. xv, 353 ; xv. ; 215.

Overlying the Laurentian series on Lake Huron and Superior, we have the Huronian system, about 10,000 feet in thickness, and consisting to a great extent of quartzites, often conglomerate, with limestones, peculiar slaty rocks, and great beds of diorite, which we are disposed to regard as altered sediments. These constitute the lower copper-bearing rocks of the lake region, and the immense beds of iron ore at Marquette and other places on the south shore of Lake Superior have lately been found by Mr. Murray to belong to this series, which is entirely wanting along the farther eastern outcrop of the Laurentian system. This Huronian series appears to be the equivalent of the Cambrian sandstones and conglomerates described by Murchison, which form mountain masses along the western coast of Scotland, where they repose in detached portions upon the Laurentian series.

Besides these systems of crystalline rocks, the latter of which is local and restricted in its distribution, we have along the great Appalachian chain, from Georgia to the Gulf of St. Lawrence, a third series of crystalline strata, which form the gneissoid and mica slate series of most American geologists, the hypozoic group of Prof. Rogers, consisting of feldspathic gneiss, with quartzites, argillites, micaceous, epidotic, chloritic, talcose and specular schists, accompanied with steatite, diorites and chromiferous ophiolites. This group of strata has been recognized by Safford in Tennessee, by Rogers in Pennsylvania, and by most of the New England geologists as forming the base of Appalachian system, while Sir William Logan, Mr. Hall, and the present writer have for many years maintained that they are really altered palæozoic sediments, and superior to the lowest fossiliferous strata of the Silurian series. Sir William Logan has shown that the gneissoid ranges in Eastern Canada have the form of synclinals, and are underlaid by shales which exhibit fossils in their prolongation, while his sections leave no doubt that these ranges of gneiss, with micaceous, chloritic, talcose and specular schists, epidosites, quartzites, diorites and ophiolites, are really the altered sediments of the Quebec group, which is a lower member of the Silurian series, corresponding to the Calciferous and Chazy formations of New York, or to the Primal and Auroral series of Pennsylvania. Prof. Rogers indeed admits that these are in some parts of Pennsylvania metamorphosed into feldspathic, micaceous and talcose rocks, which it is extremely difficult to distinguish from the hypozoic gneiss, which latter, however, he conceives to present a want of conformity with the palæozoic strata.

To this notion of the existence of two groups of crystalline rocks similar in lithological character but different in age, we have to object that the hypozoic gneiss is identical with the Green Mountain gneiss, not only in lithological character, but in the presence of certain rare metals, such as chrome, titanium, and nickel which characterise its magnesian rocks; all of these we have shown to be present in the unaltered sediments of the Quebec group, with which Sir William Logan has identified the gneiss formation in question. Besides which the lithological and chemical characters of the Appalachian gneiss are so totally distinct from the crystalline strata of the Laurentian system, with which Prof. Rogers would seem to identify them, that no one who has studied the two can for a moment confound them. Prof. Rogers is therefore obliged to assume a new series of crystalline rocks, distinct from both the Laurentian and Huronian systems, but indistinguishable from the altered palæozoic series, or else to admit that the whole of his gneissic series in Pennsylvania is, like the corresponding rocks in Canada, of palæozoic age.* We believe that nature never repeats herself without a difference, and that certain variations in the chemical and mineralogical constitution of sediments mark successive epochs so clearly that it would be impossible to suppose the formation in adjacent regions of a series of crystalline schists like those of the Alleghanies contemporaneous with the sediments which produced the Laurentian system. We have elsewhere indicated the general principles upon which is based this notion of

* Dr. Bigsby in 1824 described an extensive tract of gneissoid rocks on Rainy Lake and Lake Lacroix, north of Lake Superior. The general course of the strata he states to be "from N. W. to N. by W., with a corresponding easterly dip;" but he elsewhere speaks of the gneiss as running (dipping?) E. N. E. This gneiss often contains beds and disseminated grains of hornblende, and passes in some places into micaceous, chloritic and greenstone slates, and syenite. Staurotide is abundant in the mica schists, and octahedral iron occurs in the chloritic slates. A porphyritic granite containing beryl is also met with in this region. This gneiss is regarded by Dr. Bigsby as belonging "to transition rocks, from its constant proximity to red sandstone, the oldest organic limestone, and trap." (Am. Jour. Sci, (1) viii, 61). The lithological and mineral characters of these crystalline strata seem to be distinct from those of the Laurentian system, and to resemble those of the Appalachians. Too much praise cannot be ascribed to Dr. Bigsby for his early and extensive observations on the geognosy and mineralogy of British North America.

a progressive change in the composition of sediments, and shown how the gradual removal of alkalies from aluminous rocks has led to the formation of argillites, chloritic and epidotic rocks, at the some time removing carbonic acid from the atmosphere, while the resulting carbonate of soda by decomposing the calcareous and magnesian salts of the ocean, furnished the carbonates for the formation of limestones and dolomites, at the same time generating sea salt.*

Closely connected with these chemical questions is that of the commencement of life on the earth. The recognition beneath the Silurian and Huronian rocks of 40,000 feet of sediments analogous to those of more recent times, carries far back into the past the evidence of the existence of physical and chemical conditions, similar to those of more recent periods. But these highly altered strata exclude, for the most part, organic forms, and it is only by applying to their study the same chemical principles which we now find in operation that we are led to suppose the existence of organic life during the Laurentian period. The great processes of deoxydation in nature are dependent upon organization; plants by solar force convert water and carbonic acid into hydrocarbonaceous substances, from whence bitumens, coal, anthracite and plumbago, and it is the action of organic matter which reduces sulphates, giving rise to metallic sulphurets and sulphur. In like manner it is by the action of dissolved organic matters that oxyd of iron is partially reduced and dissolved from great masses of sediments, to be subsequently accumulated in beds of iron ore. We see in the Laurentian series beds and veins of metallic sulphurets, precisely as in more recent formations, and the extensive beds of iron ore hundreds of feet thick which abound in that ancient system, correspond not only to great volumes of strata deprived of that metal, but as we may suppose, to organic matters, which but for the then greater diffusion of iron oxyd in conditions favourable for their oxydation, might have formed deposits of mineral carbon far more extensive than those beds of plumbago which we actually meet with in the Laurentian strata.

All these conditions lead us then to conclude to the existence of an abundant vegetation during the Laurentian period, nor are there wanting evidences of animal life in these oldest strata. Sir William Logan has described forms occuring in the Laurentian

* Am. Journal of Science (2) xxv. 102, 445. xxx. 133; Quar. Journal Geol. Soc. xv. 488, and Can. Naturalist, December 1859.

limestone which cannot be distinguished from the silicified specimens of *Stromatopora rugosa* found in Lower Silurian rocks. They consist of concentric layers made up of crystalline grains of white pyroxene in one case and of serpentine in another, the first imbedded in limestone and the second in dolomite; we may well suppose that the result of metamorphism would be to convert silicified fossils into silicates of lime and magnesia. The nodules of phosphate of lime in some beds of the Laurentian limestones also recall the phosphatic coprolites which are frequently met with in Lower Silurian strata, and are in the latter case the exuviæ of animals which have fed upon *Lingula*, *Orbicula*, *Conularia* and *Serpulites*, the shells and tubes of which we have long since shown to be similar in composition to the bones of vertebrates.* So far therefore from looking upon the base of the Silurian as marking the dawn of life upon our planet, we see abundant reasons for supposing that organisms, probably as varied and abundant as those of the palæozoic age, may have existed during the long Laurentian period.

Along the northern rim of the great palæozoic basin of North America the Potsdam sandstone of the New York geologists is unquestionably the lowest rock from below Quebec to the Island of Montreal, and thence passing up the valley of Lake Champlain and sweeping round the Adirondack mountains, until it reënters Canada and soon disappears to the north of Lake Ontario, where the Birdseye and Black River limestones repose directly upon the Laurentian rocks, and furthermore overlie the great Lake Superior group of slates and sandstones, which reposing on the unconformable Huronian system, constitute the upper copper-bearing rocks of this region. This Lake Superior group, as Sir William Logan remarks, may then include the Potsdam, Calciferous and Chazy, and thus be equivalent in part to the Quebec group hereafter to be described.

Passing westward into the Mississippi valley we again find a sandstone formation, which forms the base of the palæozoic series, and is considered by Mr. Hall to be the equivalent of the Potsdam. Here it occasionally exhibits intercalated beds of silico-argillaceous limestone, in which occur abundant remains of trilobites of the genera *Dikellocephalus*, *Menocephalus*, *Arionellus*, and *Conocephalus*. Passing upwards this sandstone is succeeded by the Lower Magnesian limestone, which is the equivalent of the Calciferous sand-

* Logan and Hunt, Am. Jour. Sci. (2) xvii. 235.

rock of New York, and in Missouri, where it is the great metalliferous formation, alternates several times with a sandstone, constituting the Magnesian Limestone series, which in Missouri attains a thickness of 1300 feet. The same thing is observed to a less degree in Wisconsin and Iowa; throughout this region the higher beds of the Potsdam sandstone are often composed of rounded oolitic granules, and the beds of passage are frequently of such a character as to lead to the conclusion that they have been deposited from silica in solution, and are not mechanical sediments.* For a discussion of some facts with regard to the chemical origin of many silicious rocks, see Am. Journal of Science, (2) xviii. 381.

Evidences of disturbance during the period of its deposition are to be found in the brecciated beds, sometimes fifty feet in thickness, which occur in the Calciferous sandrock of the north-west, and are made up of the ruins of an earlier sandstone. In Missouri, the Birdseye and Black River limestones repose directly upon the Lower Magnesian limestone, while further north a sandstone intervenes, occupying the place of the Chazy limestone.

The Potsdam sandstone of the St. Lawrence valley, has for the most part the character of a littoral formation, being made up in great part of pure quartzose sand, and offering upon successive beds, ripple and wind marks, and the tracks of animals. Occasionally it includes beds of conglomerate, or as at Hemmingford, encloses large rounded fragments of green and black shale; it also exhibits calcareous beds apparently marking the passage to the succeeding formation, which although called a Calciferous sandrock, is for the most part here, as in the west, a magnesian limestone, often geodiferous, and including calcite, pearl spar, gypsum, barytes and quartz. Sir William Logan had already shown that the fauna of the Potsdam and Calciferous in Canada are apparently identical, (Can. Naturalist June 1860, Am. Jour. Sci. [2] xxxi. 18), and Mr. Hall has arrived at the same conclusion with regard to the more extended fauna of these formations in the valley of the Mississippi, so that these two may be regarded as forming but one group. While in the west *Dikellocephalus* occurs both in the lower sandstones and the magnesian limestones, *Conocephalus minutus*, found in the Potsdam on Lake Champlain, and identified by Mr. Billings, has lately been

* See Mr. Hall's Introduction, to which we are indebted for many of these facts regarding the formations of the west, and also the Reports of the Geological Survey of Missouri.

detected by him in specimens from the sandstones of Wisconsin with *Dikellocephalus*, which genus has there been found to pass upwards into the magnesian limestones. On the other hand, the sandstones of Bastard in Canada, having the characters of the Potsdam, contain *Lingula acuminata* and *Ophileta compacta*, species regarded as characteristic of the Calciferous, together with two undescribed species of *Orthoceras*, and in another locality a *Pleurotomaria* resembling *P. Laurentina*. The researches of Mr. Billings have extended the fauna of the Calciferous in Canada to forty-one species, and the succeeding Chazy formation to 129 species. The thickness of this latter division in the St. Lawrence valley is about 250 feet, and it includes in its lower part about fifty feet of sandstones with green fucoidal shales and a bed of conglomerate. The Calciferous has a thickness of about 300 feet, while the Potsdam may be estimated at not far from 600 feet.

We have then seen that along the north-eastern outcrop of the great American basin in Canada and New York, the base of the palæozoic series is represented by less than 1000 feet of sandstones and dolomites, reposing directly upon the Laurentian system. A very different condition of things is, however, found in the more central parts of the basin. According to Prof. Rogers, the older Primal slates, which form the base of the palæozoic system, attain in Virginia a thickness of 1200 feet, and are succeeded by 300 feet of Primal sandstone marked by *Scolithus*, which he considers the Potsdam, followed by the upper Primal slates, consisting of 700 feet of greenish and brownish talco-argillaceous shales with fucoids. To these succeed his Auroral division, consisting of sixty feet or more of calcareous sandstone, the supposed equivalent of the Calciferous sandrock, followed by the Auroral limestone, which is magnesian, and often argillaceous and cherty in the upper beds. Its thickness is estimated at from 2500 to 5500 feet, and it is supposed by Rogers to include the Chazy and Black River limestones, while the succeeding Matinal division exhibits first, from 300 to 550 feet of limestone, (Trenton), secondly, 300 to 400 feet black shale, (Utica), and thirdly, 1200 feet of shales with red slates and conglomerates, (Hudson River group), thus completing the Lower Silurian series.

In Eastern Tennessee, Mr. Safford describes, (1st.) on the confines of North Carolina, a great volume of gneissoid and micaceous rocks similar to those of Pennsylvania, succeeded to the west by (2nd.) the Ocoee conglomerates and sandstones, with argillites, chloritic, talcose and micaceous slates, and occasional bands of limestone, all dipping, like the rocks of the 1st division, to the S. E. In the 3rd place we have the Chilhowee sandstones and shales, several thousand feet in thickness, including near the summit beds of sandstone with *Scolithus*, and considered by Mr. Safford the equivalent of the Potsdam. (4th.) The Magnesian limestone and shale group, also several thousand feet thick, and divided into three parts: first, a series of fucoidal sandstones approaching to slates and including bands of magnesian limestone; second, a group of many hundred feet of soft brownish, greenish, and buff shales, with beds of blue oolitic limestone, which as well as the shales, contain trilobites. Passing upward these limestones become interstratified with the third sub-division, consisting of heavy bedded magnesian limestone, more or less sparry and cherty near the summit. The limestones of Knoxville belong to this group, which with the 3rd or Chilhowee group is designated by Mr. Safford as Cambrian, corresponding to the Primal and Auroral of Rogers, or to the Potsdam and Calciferous sandrock, with the possible addition of the Chazy, being equivalent to the great Magnesian limestone series of Prof. Swallow in Missouri. To these strata succeed Safford's 5th formation, consisting of limestones, the equivalents of the Black River, Trenton and higher portions of the Lower Silurian.

In Eastern Canada we find a group of strata similar to those described by Rogers and Safford, and distinguished by Sir William Logan as the Quebec group. It has for its base a series of black and blue shales, often yielding roofing slates, succeeded by grey sandstone and great beds of conglomerate, with dolomites and pure limestones, often concretionary and having the character of travertines. These are associated with beds of fossiliferous limestones, and with slates containing compound graptolites, and are followed by a great thickness of red and green shales, often magnesian, and overlaid by 2000 feet of green and red sandstone, known as the Sillery sandstone, the whole from the base of the conglomerate, having a thickness about 7000 feet. These red and green shales resemble closely those at the top of the Hudson River group, and the succeeding sandstones are so much like those of the Oneida and Medina formations, that the Quebec group was for a long time regarded as belonging to the summit of the Lower Silurian series, the more so as by a great break and upthrow to the S. E., the rocks of this group are made to overlap the Hudson River formation. "Sometimes it may overlie the overturned Utica formation, and in Vermont, points of the overturned Trenton appear occasionally to emerge from beneath the overlap."* This great dislocation is traceable in a gently curving line from near Lake Champlain to Quebec, passing just north of the fortress; thence it traverses the island of Orleans, leaving a band of higher strata on the northern part of the island, and after passing under the waters of the Gulf, again appears on the main land about eighty miles from the extremity of Gaspé, where on the north side of the break, we have as in the island of Orleans, a band of Utica or Hudson River strata. To the south and east of this line the rocks of the Quebec group are arranged in long, narrow, parallel, synclinal forms, with many overturn dips. These synclinals are separated by dark gray and black shales, with limestones, hitherto regarded as of Hudson River age, but which are perhaps the deep-sea equivalent of the Potsdam.

The presence of conglomerates and sandstones, alternating with great masses of fine shales, indicates a period of frequent disturbances, with elevations and depressions of the ocean's bottom, while the deposits of dolomite, magnesite, travertine and highly metalliferous strata show the existence of shallow water, lagoons and springs over a great area and for a long period between the formation of the upper and lower shales. We may suppose that while the Potsdam sandstone was being deposited along the shores of the great palæozoic ocean, the lower black shales were accumulating in the deeper waters, after which an elevation took place, and the magnesian strata were deposited, followed by a subsidence during the period of the upper shales and Sillery sandstones.

Associated with the magnesian strata at Point Levis and in several other localities in the same horizon of the Quebec group, an extensive fauna is found, of which 137 species are now known, embracing more than forty new species of graptolites, which have been described by Mr. James Hall in the report of the Geological Survey of Canada for 1857, and thirty-six species of trilobites described by Mr. Billings in the Canadian Naturalist for August 1860. These species are as yet distinct from anything found in the Potsdam below or the Birdseye and Black River above;

* See Sir William Logan's letter to Mr. Barrande, Canadian Naturalist for Jan. 1861, and Am. Journal. of Science (2) xxxi. 216.

although the trilobites recall by their aspect those found by Owen in the Lower Sandstone of the Mississippi. Seven species alone out of this fauna have been identified with those known in other formations, and of these one is Chazy, while six belong to the Calciferous, to which latter horizon Mr. Billings considers the Quebec group to belong. The Chazy has not yet been identified in this region, unless indeed it be represented in some of the upper portions of the Quebec group. The Calciferous sand-rock is wanting along the north side of the St. Lawrence valley from near Lake St. Peter to the Mingan Islands, but at Lorette behind Quebec, at the foot of the Laurentides, the Birdseye limestone is found reposing conformably upon the Potsdam sandstone.

It is not easy to find the exact horizon of the Potsdam sandstone among the black shales which underlie the Quebec group. The *Scolithus* of Rogers' Primal sandstone, and of the summit of Safford's 3rd or Chilhowee formation is identical with that found in the quartz rock at the western base of the Green Mts, and figured by Mr. Hall in the 1st volume of the Palæontology. It is however distinct from what has been called *Scolithus* in the Potsdam of Canada. The value of this fossil as a means of identification is diminished by the fact that similar marks are found in sandstones of very different ages. Thus a *Scolithus* very like that of the St. Lawrence valley occurs in the sandstone of Lake Superior and in the Medina sandstone, while in Western Scotland, according to Mr. Salter, the two quartzite formations above and below the Lower Silurian limestones of Chazy age are alike characterized by these tubular markings, which are regarded by him as produced by annelids or sea-worms. We find however in shales which underlie the Quebec group at Georgia in Vermont, trilobites which were described by Mr. Hall in 1859 as belonging to the genus *Olenus*, a recognized primordial type; he has since erected them into a new genus. Again at Braintree in Eastern Massachusetts occur the well known *Paradoxides* in an argillaceous slate. These latter fossils Mr. Hall suggests probably belong to the same horizon as certain slaty beds in the Potsdam sandstone, or perhaps even at the base of this formation. (Introduction, page 9.) In this connection we must recall the similar shales of Newfoundland, in which Salter has recognized trilobites of the same genus. These shales containing *Paradoxides*, like those underlying the Quebec group, thus appear to belong to the so-called Primordial zone, and are to be regarded as the equivalents of the Potsdam sandstone, which both on Lake Champlain and in the Mississippi valley is characterized by primordial types. The intermingling of Potsdam and Calciferous forms to which we have already alluded, seems however to show that it will be difficult to draw any well defined zoological horizon between the different portions of these lower rocks, which at the same time offer as yet no evidences of any fauna lower than that of the Potsdam. So that we regard the whole Quebec group with its underlying Primordial shales as the greatly developed representative of the Potsdam and Calciferous (with perhaps the Chazy), and the true base of the Silurian system.

The Quebec group with its underlying shales is no other than the Taconic system of Emmons. Distinct in their lithological characters from the Potsdam and Calciferous formations as developed on Lake Champlain, Mr. Emmons was led to regard these strata as belonging to a lower or sub-Silurian group. We have however shown that the paleontological evidence afforded by this formation gives no support to such a view. To Mr. Emmons is however undoubtedly due the merit of having for a long time maintained that the Taconic hills are composed of strata inferior to the Trenton limestones, brought up into their present position by a great dislocation, with an upthrow on the eastern side. We would not object to the term Taconic if used as indicating a subdivision of the Lower Silurian series, but as the name of a distinct and sub-Silurian system it can no longer be maintained. The Quebec group evidently increases in thickness as we proceed towards the south, and the calcareous parts of the formation are more developed. In 1859, I visited in company with Mr. A. D. Hager the marble quarries of Rutland and Dorset, in Vermont. The latter occur in a remarkable synclinal mountain of nearly horizontal strata of marble and dolomite, capped by shales, and attaining a height of 2700 feet above the railway station at its base. I then identified these marbles with the limestones of the Quebec group, considering them to be beds of chemically precipitated carbonate of lime or travertine, and not limestones of organic origin.

The existence of great dislocations in the Appalachian chain is amply illustrated in the sections of Prof. Rogers, and in those given by Safford in Eastern Tennesse, where by the aid of fossils it becomes comparatively easy to trace them. See the Map accompanying his *Geological Reconnaissance of Tennessee*, 1855; where the magnesian limestones of formation IV, are shown to be not only brought up on the east against the Upper Silurian and Devonian, but even to overlap the black shales at the base of the Carboniferous system. It is remarkable to find that as early as 1822, the idea of a great dislocation of this nature in Eastern New York was maintained by Mr. D. H. Barnes in his description of Canaan Mountain. [Am. Journal of Science, (1) v. pp. 15–18.]

To the southeast of this great fault in Canada we have as yet no evidence of Lower Silurian strata higher than those of the Quebec group. At the eastern base of the Green Mts. we find limestones of upper Silurian and Devonian age reposing unconformably upon the altered strata of the Quebec group, themselves also having undergone more or less alteration. Immediately succeeding are the chiastolite and mica slates of Lake St. Francis, which as we have long since stated are probably also of Upper Silurian age.

The White Mountains as we suggested in 1849, (Am.Jour.Sci. (2) ix. 19) are probably, in part at least, of Devonian age, and are the representatives of the 7000 feet of Devonian sandstone observed by Sir William Logan in Gaspé. Mr. J. P. Lesley has more recently, after an examination of the White Mts. shown that they possess a synclinal structure, and has adduced many reasons for regarding them as of Devonian age. (Amer. Mining Journal, January 1861, p. 99.

It will be seen from what has been previously said that we look upon the 1st and 2nd divisions described by Mr. Safford in Eastern Tennessee, as corresponding to the hypozoic series of Rogers and to the Green Mountain gneissic formation, which instead of being beneath the Silurian series, is really a portion of the Quebec group more or less metamorphosed, so that we recognize nothing in New England or south-eastern Canada lower than the Silurian system, nor do we at present see any evidence of older strata, such as Laurentian or Huronian, in any part of the Appalachian chain. The general conclusions which we have previously expressed with regard to the lithological, chemical and mineral relations of the Green Mts. rocks remain unchanged. [Am. Journal of Science (2) ix. 12.]

The remarkable parallelism between the rocks of Western Scotland and Canada has already been shown in the existence of the Laurentian, and Cambrian (Huronian) systems, overlaid by quartzites containing *Scolithus*, to which succeed limestones containing a numerous fauna, identified by Mr. Salter with that of the Chazy limestone. These strata, with an eastward dip, are covered by other quartzites and limestones, to which succeeds the great gneissoid formation of the western Highlands, consisting of feldspathic, chloritic, micaceous, and talcose schists resembling closely the gneissoid rocks of the Green Mts. and including the chromiferous ophiolites of Perthshire, Banff and the Shetland Isles.

This gneissoid series was by Prof. Nicol suggested to be the older or Laurentian gneiss brought up by a dislocation on the east of the Silurian limestones, but Sir Roderick Murchison, with Messrs. Ramsay and Harkness, has shown not only from the differences in lithological character, but from actual sections, that the eastern gneissoid series is made up of altered strata newer than the Silurian limestones.* Thus in geological structure and age, not less than in lithological and mineralogical characters, the rocks of the western Highlands are the counterparts of the Laurentian and Silurian gneiss formations, as seen in the Laurentides and Adirondacks, and in the Green Mts. The same parallelism may be extended to Scandinavia, (where Kjerulf and Forbes have shown much of the crystalline gneiss to be of Silurian age,) marking as it would seem the outer edge of a vast Silurian basin, which may be followed in the other direction across the Atlantic to the Gulf of Mexico. We also remark in Great Britain as in America, that whereas the northern outcrop of the palæozoic basin offers at its base only a series of quartzose sandstones reposing upon the Laurentian system and characterized by fucoids and *Scolithus*, we find further south in England an immense development of shales, sandstones and conglomerates, which form the base of the Silurian system and correspond to the Primordial zone and the Quebec group.

We have said that upon Lake Huron and Superior the sandstones of the upper copper-bearing rocks are the equivalents of the Quebec group. The clear exposition of the question by Mr. J. D. Whitney in the Am. Mining Jour. for 1860 (p. 435) left little more to be said, but the sections made last year by Mr. Alex. Murray of the Canada Geological Survey place the matter beyond all doubt. On Campment d'Ours, a small island near St. Joseph's, the sandstones of Sault St. Mary are seen reposing horizontally on the upturned edges of the Huronian rocks, and overlaid by limestones which contain in abundance the fossils of the Black River and

* Murchison, Quar. Jour. Geol. Society, Vol. xv. 353 and xvi. 215.

Birdseye divisions. The only fossil as yet found in these sandstones is a single *Lingula* from near Sault St. Mary, which may be either of Potsdam or Chazy age. The sandstones in question form the upper member of a series of strata which on Lake Superior attain a thickness of several thousand feet, and passing downwards we find a succession of limestones, marls and argillaceous sandstones, interstratified with greenstone and amygdaloid, and followed by about 2000 feet of bluish slates and sandstones, with cherty beds containing grains of anthracite, the whole underlaid by conglomerates, and reposing unconformably upon rocks of the Huronian system. The presence of such slates is the more significant from the occurrence already mentioned of fragments of green and black slates in the coarse grained sandstones near the base of the Potsdam, at Hemmingford mountain, showing the existence of argillaceous shales before the deposition of the quartzites of the Potsdam; these are perhaps more recent than the lowest shales of the Primordial zone, to which however, palæontologically they appear to belong.

This Quebec group is of considerable economic interest inasmuch as it is the great metalliferous formation of North America. To it belongs the gold which is found along the Appalachian chain from Canada to Georgia, together with lead, zinc, copper, silver, cobalt, nickel, chrome and titanium. I have long since called attention to the constant association of the latter metals, particularly chrome and nickel, with the ophiolites and other magnesian rocks of this series, while they are wanting in similar rocks of Laurentian age. Am. Jour. of Science (2) xxvi. 237.

The immense deposits of copper ores in Eastern Tennessee, and the similar ones in Lower Canada, both of which are for the most part in beds subordinate to the stratification, belong to this group. The lead, copper, zinc, cobalt and nickel of Missouri, and the copper of Lake Superior, also occur in rocks of the same age, which appears to have been pre-eminently the metalliferous period.

The metals of the Quebec group seem to have been originally brought to the surface in watery solution, from which we conceive them to have been separated by the reducing agency of organic matter in the form of sulphurets, or in the native state, and mingled with the contemporaneous sediments, where they occur in beds, in disseminated grains forming *fahlbands*, or as at Acton, are the cementing material of conglomerates. During the subsequent metamorphism of the strata these metallic matters being taken into solution by alkaline carbonates or sulphurets, have been redeposited in fissures in the metalliferous strata, forming veins, or ascending to higher beds, have given rise to metalliferous veins in strata not themselves metalliferous. Such we conceive to be in a few words the theory of metallic deposits; they belong to a period when the primal sediments were yet impregnated with metallic compounds which were soluble in the permeating waters. The metals of the sedimentary rocks are now however for the greater part in the form of insoluble sulphurets, so that we have only traces of them in a few mineral springs, which serve to show the agencies once at work in the sediments and waters of the earth's crust. The present occurrence of these metals in waters which are alkaline from the presence of carbonate of soda, is as we have elsewhere pointed out, of great significance when *taken in connection with the metalliferous character of certain* dolomites, which as we have shown, probably owe their origin to the action of similar alkaline springs upon basins of sea water.

The intervention of intense heat, sublimation and similar hypotheses to explain the origin of metallic ores, we conceive to be uncalled for. The solvent powers of solutions of alkaline carbonates, chlorids and sulphurets at elevated temperatures, taken in connection with the notions above enunciated, and with De Senarmont's and Daubrée's beautiful experiments on the crystallization of certain mineral species in the moist way, will suffice to form the basis of a satisfactory theory of metallic deposits.*

The sediments of the carboniferous period, like those of earlier formations, exhibit towards the east a great amount of coarse sediments, evidently derived from a wasting continent, and are nearly destitute of calcareous beds. In Nova Scotia Sir William Logan found by careful measurement, 14,000 feet of carboniferous strata; and Professor Rogers gives their thickness in Pennsylvania as 8000 feet, including at the base 1400 feet of a conglomerate, which disappears before reaching the Mississippi. In Missouri Prof. Swallow finds but 640 feet of carboniferous strata, and in Iowa their thickness is still less, the sediments composing them being at the same time of finer materials. In fact, as Mr. Hall remarks, throughout the whole palæozoic period we observe a greater accumulation and a coarser character of sediments along the line of the Appalachian chain, with a gradual thinning westward, and a deposition of finer and farther transported matter in that direction. To the

* Quar. Jour. Geol. Soc. vol. xv. 580.

west, as this shore-derived material diminishes in volume, the amount of calcareous matter rapidly augments. Mr. Hall concludes therefore that the coal-measure sediments were driven westward into an ocean, where there already existed a marine fauna. At length, the marine limestones predominating, the coal measures come to be of little importance, and we have a great limestone formation of marine origin, which in the Rocky Mountains and New Mexico occupies the horizon of the coal, and itself unaltered, rests on crystalline strata like those of the Appalachian range. In truth, Mr. Hall observes, the carboniferous limestone is one of the most extensive marine formations of the continent, and is characterized over a much greater area by its marine fauna than by its terrestrial vegetation.

"The accumulations of the coal period were the last that gave form and contour to the eastern side of our continent, from the Gulf of St. Lawrence to the Gulf of Mexico; and as we have shown that the great sedimentary deposits of successive periods have followed essentially the same course, parallel to the mountain ranges, we naturally inquire: What influence this accumulation has had upon the topography of our country, and whether the present line of mountain elevation from north-east to south-west is in any way connected with the original accumulation of sediments?" *Hall's Introduction*, p. 66.

The total thickness of the palæozoic strata along the Appalachian chain is about 40,000 feet, while the same formations in the Mississippi valley, including the carboniferous limestone, which is wanting in the east, have according to Mr. Hall, a thickness of scarcely 4000 feet.* In many places in this valley we find the Silurian formations exposed, exhibiting hills of 1000 feet, made up of horizontal strata, with the Potsdam sandstone for their base, and capped by the Niagara limestone, while the same strata in the Appalachians would give from ten to sixteen times that

* In Michigan, according to the late report of Prof. Winchell, the total observed thickness of the strata from the top of the Sault St. Mary sandstones to the top of the carboniferous series is little over 1700 feet, divided as follows:—Trenton and Hudson River groups, 50 feet, Upper Silurian 185, Devonian 782, Carboniferous 700; of this last the true coal measures constitute 123 feet, including from 3 to 10 feet of workable bituminous and cannel coals, while near the base of the carboniferous series are found 169 feet of gypsiferous marls, which yield strong brine springs.

thickness. Still, as Mr. Hall remarks, we have there no mountains of corresponding altitude, that is to say, none whose height, like those of the Mississippi valley, equals the actual vertical thickness of the strata comprising them. In the west there has been little or no disturbance, and the highest elevations mark essentially the aggregate thickness of the strata comprising them. In the disturbed regions of the east on the contrary, though we can prove that certain formations of known thickness are included in *the mountains, the height of these is never equal to the aggregate* amount of the formations. "We thus find that in a country not mountainous, the elevations correspond to the thickness of the strata, while in a mountainous country, where the strata are immensely thicker, the mountain heights bear no comparative proportion to the thickness of the strata." "While the horizontal strata give their whole elevation to the highest parts of the plain, we find the same beds folded and contorted in the mountain region, and giving to the mountain elevations not one-sixth of their actual measurement."

Both in the east and west, the valleys exhibit the lower strata of the palæozoic series, and it is evident that had the eastern region been elevated without folding of the strata, so as to make the base of the series correspond nearly with the sea level, as in the Mississippi valley, the mountains exposed between these valleys, and including the whole palæozoic series, would have a height of 40,000 feet; so that the mountains evidently correspond to depressions of the surface, which have carried down the bottom rocks below the level at which we meet them in the valleys. In other words, the synclinal structure of these mountains depends upon an actual subsidence of the strata along certain lines.

"We have been taught to believe that mountains are produced by upheaval, folding and plication of the strata, and that from some unexplained cause these lines of elevation extend along certain directions, gradually dying out on either side, and subsiding at the extremities. We have, however, here shown that the line of the Appalachian chain is the line of the greatest accumulation of sediments, and that this great mountain barrier is due to original deposition of materials, and not to any subsequent forces breaking up or disturbing the strata of which it is composed."

We have given Mr. Hall's reasonings on this subject, for the most part in his own words, and with some detail, for we conceive that the views which he is here urging are of the highest importance to a correct understanding of the theory of mountains. In the *Canadian Naturalist* for Dec. 1859, p. 425, and in the *Am. Jour. Sci.* (2) xxx, 137 will be found an allusion to the rival theories of upheaval and accumulation as applied to volcanic mountains, the discussion between which we conceive to be settled in favour of the latter theory by the reasonings and observations of Constant-Prevost, Scrope and Lyell. A similar view applied to mountain chains like those of the Alps, Pyrennees and Alleghanies, which are made up of aqueous sediments, has been imposed upon the world by the authority of Humboldt, Von Buch and Elie de Beaumont, with scarcely a protest. Buffon, it is true, when he explained the formation of continents by the slow accumulation of detritus beneath the ocean, conceived that the irregular action of the water would give rise to great banks or ridges of sediments, which when raised above the waves must assume the form of mountains; later, in 1832, we find De Montlosier protesting against the elevation hypothesis of Von Buch, and maintaining that the great mountain chains of Europe are but the remnants of continental elevations which have been cut away by denudation, and that the foldings and inversions to be met with in the structure of mountains are to be looked upon only as local and accidental.

In 1856 Mr. J. P. Lesley published a little volume entitled *Coal and its Topography*, (12 mo. pp. 224,) in the second part of which he has, in a few brilliant and profound chapters, discussed the principles of topographical science with the pen of a master. Here he tells us that the mountain lies at the base of all topographical geology. Continents are but congeries of mountains, or rather the latter are but fragments of continents, separated by valleys which represent the absence or removal of mountain land [p. 126]; and again "mountains terminate where the rocks thin out." (p. 144.)

The arrangement of the sedimentary strata of which mountains are composed may be either horizontal, synclinal, anticlinal or vertical, but from the greater action of diluvial forces upon anticlinals in disturbed strata it results that great mountain chains are generally synclinal in their structure, being in fact but fragments of the upper portion of the earth's crust, lying in synclinals, and thus preserved from the destruction and translation which have exposed the lower strata in the anticlinal valleys, leaving the intermediate mountains capped with lower strata. The effects of those great and mysterious denuding forces which have so powerfully modified the surface of the globe become less apparent as we approach the equatorial regions, and accordingly we find that in the southern portions of the Appalachian chain many of the anticlinal folds have escaped erosion, and appear as hills of an anticlinal structure. The same thing is occasionally met with further north; thus Sutton mountain in Canada, lying between two anticlinal valleys, has an anticlinal centre, with two synclinals on its opposite slopes. Its form appears to result from three anticlinals, the middle one of which has to a great extent escaped denudation.

The error of the prevailing ideas upon the nature of mountain chains may be traced to the notion that a disturbed condition of the rocky strata is not only essential to the structure of a mountain, but an evidence of its having been formed by local upheaval, and the great merit of De Montlosier and Lesley, (the latter altogether independently,) is to have seen that the upheaval has been in all cases not local but continental, and that the disturbance so often seen in the strata is neither dependent upon elevation nor essential to the formation of a mountain. The synclinal structure of portions of the Alps, previously observed by Studer and others, has been beautifully illustrated by Ruskin in the fourth volume of his *Modern Painters*, and in a late review of Alpine geology we have endeavoured to show that the Alps, *as a whole*, have likewise a synclinal structure. (Am. Jour. Science, xxix. 118.)

Such was the state of the question when Mr. Hall came forward bringing his great knowledge of the sedimentary formations of North America to bear upon the theory of continents and mountains. These were first advanced in his address delivered before the American Association for the Advancement of Science, as its president, at Montreal in August, 1857. This address was never published, but the author's views were brought forward in the first volume of his *Report on the Geology of Iowa*, p. 41, and with more detail in the introduction to the third volume of his *Paleontology of New York*, from which we have taken the abstract already given. He has shown that the difference between the geographical features of the eastern and central parts of North America is directly connected with the greater accumulation of sediment along the Appalachians. He has further shewn that so far from local elevation being concerned in the formation of these mountains, the strata which form their base are to be found beneath their foundations at a much lower horizon than in the undisturbed hills of the Mississippi valley, and that to this depression chiefly is due the fact that the mountains of the Appalachian range do not, like those hills, exhibit in their vertical height above the sea the whole accumulated thickness of the palæozoic strata which lie buried beneath their summits.

Mr. Hall has made a beautiful application of these views to explain the fact of the height of the Green Mountains over the Laurentides, and of the White Mountains over the former, by remarking that we have successively the Lower and Upper Silurian strata superimposed on those of the Laurentian system. The same thing is strikingly shown in the fact that the higher mountain chains of the globe are composed of newer formations, and that the summits of the Alps are probably altered sediments of tertiary age. (Am. Jour. Sci. xxix. 118.)

The lines of mountain elevation of De Beaumont are according to Hall, simply those of original accumulations, which took place along current or shore lines, and have subsequently, by continental elevations, produced mountain chains. "They were not then due to a later action upon the earth's crust, but the course of the chain and the source of the materials were predetermined by forces in operation long anterior to the existence of the mountains or of the continent of which they form a part." p. 86.

It will be seen from what we have said of Buffon, De Montlosier and Lesley that many of the views of Mr. Hall are not new but old; it was, however, reserved to him to complete the theory and give to the world a rational system of orographic geology. He modestly says, "I believe I have controverted no established fact or principle beyond that of denying the influence of local elevating forces, and the intrusion of ancient or plutonic formations beneath the lines of mountains, as ordinarily understood and advocated. In this I believe I am only going back to the views which were long since entertained by geologists relative to continental elevations." p. 82.

The nature of the palæozoic sediments of North America clearly shows that they were accumulated during a slow progressive subsidence of the ocean's bed, lasting through the palæozoic period, and this subsidence, which would be greatest along the line of greatest accumulation, was doubtless, as Mr. Hall considers, connected with the transfer of sediment and the variations of local pressure acting upon the yielding crust of the earth, agreeably to the view of Sir John Herschel. This subsidence of the ocean's bottom would, according to Mr. Hall, cause plications in the soft and yielding strata. Lyell had already in speculating upon the results of a cooling and contracting sea of molten matter, such as he imagined might have once underlaid the Appalachians, suggested that the incumbent flexible strata, collapsing in obedience to gravity would be forced, if this contraction took place along narrow and parallel zones of country, to fold into a smaller space as they conformed to the circumference of a smaller arc, "thus enabling the force of gravity, though originally exerted vertically, to bend and squeeze the rocks as if they had been subjected to lateral pressure.*

Admitting thus Herschel's theory of subsidence and Lyell's of plication, Mr. Hall proceeds to inquire into the great system of foldings presented by the Appalachians. The sinking along the line of greatest accumulation produces a vast synclinal, which is that of the mountain ranges, and the result of such a sinking of flexible beds will be the production within the greater synclinal of numerous smaller synclinal and anticlinal axes, which must gradually decline toward the margin of the great synclinal axis. This process the author observes appears to furnish a satisfactory explanation of the difference of slope on the two sides of the Appalachian anticlinals, where the dips on one side are uniformly steeper than on the other. p. 71.

An important question here arises, which is this ;—while admitting with Lyell and Hall that parallel foldings may be the result of the subsidence which accompanied the deposition of the Appalachian sediments, we inquire whether the cause is adequate to produce the vast and repeated flexures presented by the Alleghanies. Mr. Billings in a recent paper in the *Canadian Naturalist* (Jan. 1860), has endeavoured to show that the foldings thus produced must be insignificant when compared with the great undulations of strata, whose origin Prof. Rogers has endeavoured to explain by his theory of earthquake waves propagated through the igneous fluid mass of the globe, and rolling up the flexible crust. We shall not stop to discuss this theory, but call attention to another agency hitherto overlooked, which must also cause contraction and folding of the strata, and to which we have already alluded. (Am. Jour. Sci.(2)xxx. 138.) It is the condensation which must take place when porous sediments are converted into crystalline rocks like

* Travels in North America, 1st visit, vol. i. p. 78.

gneiss and mica slate, and still more when the elements of these sediments are changed into minerals of high specific gravity, such as pyroxene, garnet, epidote, staurotide, chiastolite and chloritoid. This contraction can only take place when the sediments have become deeply buried and are undergoing metamorphism, and is, as many attendant phenomena indicate, connected with a softened and yielding condition of the lower strata.

We have now in this connection to consider the hypothesis which ascribes the corrugation of portions of the earth's crust to the gradual contraction of the interior. An able discussion of this view will be found in the *American Journal of Science* (2) iii. 176, from the pen of Mr. J. D. Dana, who, in common with all others who have hitherto written on the subject, adopts the notion of the igneous fluidity of the earth's interior.

We have however elsewhere given our reasons for accepting the conclusion of Hopkins and Hennessy that the earth, instead of being a liquid mass covered with a thin crust, is essentially solid to a great depth, if not indeed to the centre, so that the volcanic and igneous phenomena generally ascribed to a fluid nucleus have their seat, as Keferstein and after him Sir John Herschel long since suggested, not in the anhydrous solid unstratified nucleus, but in the deeply buried layers of aqueous sediments which, permeated with water, and raised to a high temperature, become reduced to a state of more or less complete igneo-aqueous fusion. So that beneath the outer ust of sediments, and surrounding the solid nucleus, we may suppose a zone of plastic sedimentary material adequate to explain all the phenomena hitherto ascribed to a fluid nucleus. (Quar. Jour. Geol. Society, Nov. 1859. Canadian Naturalist, Dec. 1859, and Amer. Jour. Sci.(2)xxx. 136.)

This hypothesis, as we have endeavoured to show, is not only completely conformable with what we know of the behaviour of aqueous sediments impregnated with water and exposed to a high temperature, but offers a ready explanation of all the phenomena of volcanos and igneous rocks, while avoiding the many difficulties which beset the hypothesis of a nucleus in a state of igneous fluidity. At the same time any changes in volume resulting from the contraction of the nucleus would affect the outer crust through the medium of the more or less plastic zone of sediments, precisely as if the whole interior of the globe were in a liquid state.

The accumulation of a great thickness of sediment along a given line would, by destroying the equilibrium of pressure, cause the somewhat flexible crust to subside; the lower strata becoming altered by the ascending heat of the nucleus would crystallize and contract, and plications would thus be determined parallel to the line of deposition. These foldings, not less than the softening of the bottom strata, establish lines of weakness or of least resistance in the earth's crust, and thus determine the contraction which *results from the cooling of the globe to exhibit itself in those regions* and along those lines where the ocean's bed is subsiding beneath the accumulating sediments. Hence we conceive that the subsidence invoked by Mr. Hall, although not the sole nor even the principal cause of the corrugations of the strata, is the one which determines their position and direction, by making the effects produced by the contraction not only of sediments, but of the earth's nucleus itself, to be exerted along the lines of greatest accumulation.

It will readily be seen that the lateral pressure which is brought to bear upon the strata of an elongated basin by the contraction of the globe, would cause the folds on either side to incline to the margin of the basin, and hence we find along the Appalachians, which occupy the western side of such a great synclinal, the steeper slopes, the overturn dips or folded flexures, and the overlaps from dislocation are to the westward, so that the general dip of the strata is to the centre of the basin, on the other side of which we might expect to find the reverse order of dips prevailing. The apparent exceptions to this order of upthrows to the south-east in the Appalachians appear to be due to small downthrows to the south-east, which are parallel to and immediately to the north-west of great upheavals in the same direction.

Mr. Hall adopts the theory of metamorphism which we have expounded in the paper just quoted above, *Canadian Naturalist*, Dec. 1859, (see also Am. Jour. Sci. (2) xxv. 287, 435, xxx. 135,) which has received a strong confirmation from the late researches of *Daubrée. According to this view*, which is essentially that put forward by Herschel and Babbage, these changes have been effected in deeply buried sediments by chemical reactions, which we have endeavored to explain, so that metamorphism, like folding, takes place along the lines of great accumulation. The appearance at the surface of the altered strata is the evidence of a considerable denudation. It is probable that the gneissic rocks of Lower Silurian age in North America were at the time of their crystallization overlaid by the whole of the palæozoic strata, while the metamorphism of carboniferous strata in eastern New England points to the former existence of great deposits of newer and overlying deposits, which were subsequently swept away.

On the subject of igneous rocks and volcanic phenomena, Mr. Hall insists upon the principles which we were, so far as we know the first to point out, namely their connection with great accumulations of sediment, and of active volcanos with the newer deposits. We have elsewhere said: "the volcanic phenomena of the present day appear, so far as are aware, to be confined to regions of newer secondary and tertiary deposits, which we may suppose the central heat to be still penetrating, (as shewn by Mr. Babbage,) a process which has long since ceased in the palæozoic regions." To the accumulation of sediments then we referred both modern volcanos and ancient plutonic rocks; these latter, like lavas, we regard in all cases as but altered and displaced sediments, for which reason we have called them exotic rocks. (Am. Jour. Sci. (2) xxx. 133). Mr. Hall reiterates these views, and calls attention moreover to the fact that the greatest outbursts of igneous rock in the various formations appear to be in all cases connected with rapid accumulation over limited areas, causing perhaps disruptions of the crust, through which the semi-fluid stratum may have risen to the surface. He cites in this connection the traps with the palæozoic sandstones of Lake Superior, and with the mesozoic sandstones of Nova Scotia and the Connecticut and Hudson valleys.

It may sometimes happen that the displaced and liquified substratum will find vent, not along the line of greatest accumulation, but along the outskirts of the basin. Thus in eastern Canada it is not along the chain of the Notre Dame mountains, but on the north-west side of it that we meet with the great outbursts of trachyte and dolerite, whose composition and distribution we have elsewhere described. (Report of Geological Survey for 1858, and Am. Jour. Science, (2) xxix. 285.)

The North American continent, from the grand simplicity of its geological structure and from the absence, over great areas, of the more recent formations, offers peculiar facilities for the solution of some of the great problems of geology; and we cannot finish this article without congratulating ourselves upon the great progress in this direction which has been made within the last few years by the labors of American geologists.

Montreal, March 1, 1861.

ARTICLE VII.—*Correspondence of* JOACHIM BARRANDE, SIR WILLIAM LOGAN *and* JAMES HALL, *on the Taconic System and on the age of the Fossils found in the Rocks of Northern New England, and the Quebec Group of Rocks.*

(*From the American Journal of Science No.* 92, 1861.)

I. INTRODUCTORY REMARKS.

As some of our foreign readers may not be acquainted with the question to which the following important correspondence relates, we think it advisable to make a few explanatory observations by way of introduction. A complete history of the whole subject would require a greater amount of space than can be afforded, and we shall therefore touch only upon a few of the more salient points.

The rocks under discussion occupy a belt of country east and west from twenty to sixty miles wide, stretching from the vicinity of the city of New York in a northerly direction to Lake Champlain and thence through Vermont and Lower Canada to Cape Gaspé at the mouth of the St. Lawrence. The strata, consisting of slates, limestones, sandstones and conglomerates are greatly disturbed, plicated and dislocated, and are often, especially along the eastern side of the belt, in a highly metamorphic condition. *On this side they are overlaid unconformably by Upper Silurian* and Devonian rocks, but on the western and northern margin they are in contact with and in general seem to be a continuation of the Lower Silurian. Some of the slates of the formation closely resemble in lithological characters those of the Hudson River group, and thus along the western side of the region, where the junction of the two formations occurs, it is often almost impossible to draw the line between them. The dip and strike of both are in the same direction, and throughout extensive areas the newer rocks appear to plunge beneath the older. The whole district affords an excellent example of those cases, so well known to field geologists, where the true relations of the different masses cannot be clearly worked out without the aid of fossils, and where the best observers may arrive at diametrically opposite opinions.

Dr. Emmons, one of the geologists of the New York Survey, early convinced himself by a careful examination of these rocks, that they constituted a distinct physical group more ancient than the Potsdam sandstone, the latter being regarded by him as the base of the Lower Silurian System in North America. His views were given in detail in 1842 in his final report on that part of the State confided to his charge, and in a more special manner in another work entitled "THE TACONIC SYSTEM," published in 1844. In this latter work he figured several species of fossils which had been collected in different parts of the formation. Two of these were trilobites, and were described under the names of *Atops trilineatus* and *Elliptocephala asaphoides.* The others were graptolites, fucoids and apparently trails of annelides; he considered all the species to be distinct from any that had been found in American rocks of undoubted Silurian age. The pre-silurian age of the formation has also been maintained by him in several more recent publications such as his "American Geology"—the several reports on the geological survey of North Carolina and in his "Manual of Geology."

On the other hand, Professor Hall placed the whole region in the Hudson River group. In the first volume of the Palæontology of New York he identifies *Atops trilineatus* with *Triarthrus Beckii*, the characteristic trilobite of the Utica slate;—*Elliptocephala asaphoides* he refers to the genus *Olenus*, and describes as congeneric therewith, another trilobite (*O. undulostriatus*) said to be from the true Hudson River shales. It is scarcely necessary to state that these identifications have always afforded an extremely powerful objection against the correctness of the position assumed by Emmons, because no species of trilobite is known to range from the Primordial zone up to the top of the Lower Silurian. Hall's first volume was published in 1847 and as it is unquestionably the most important work on the Lower Silurian fossils of North America it has been very generally accepted by our physical geologists as a guide. It is not surprising therefore, that in all the discussions that have taken place during the last fourteen years upon the age of these rocks, the majority of those who did not profess to be naturalists should have arranged themselves on the side of the leading palæontologist of the country.

The formation was traced from New York through Vermont, and there identified by Prof. Adams, the State Geologist, with the Hudson River group. The Canadian Surveyors continued it with great labor through a mountainous and partially uninhabited country for nearly five hundred miles further, from the northern extremity of Vermont to the neighborhood of Quebec, and thence along the south side of the St. Lawrence to the mouth of that river at Cape Gaspé. In Canada the nomenclature of the New York Survey was adopted for all the formations, and it appears from his several reports that Sir W. E. Logan could find nothing in the physical structure of the country to authorize him to make an exception in favor of this particular series of rocks. It has therefore always been called the Hudson River group in the publications of the Canadian Survey.

It will be seen by the following correspondence that the new light thrown upon the question of the age of these rocks by the fortunate discovery of a large number of fossils near Quebec, now leads Sir William to place them at the base of the Lower Silurian, and as he states that the shales in Vermont, in which the trilobites noticed in Mr. Barrande's letter to Prof. Bronn have been found, may be subordinate to the Potsdam, it seems probable that the sequence contended for by Emmons will turn out to be at least for the greater part the true one.

II.

On the Primordial Fauna and the Taconic System of Emmons, in a letter to Prof. Bronn of Heidelberg.*

"Paris, July 16, 1860.

"........ I have recently received, thanks to the kindness of Mr. E. Billings, the learned palæontologist of the Geological Survey of Canada, a very interesting pamphlet entitled 'Twelfth Annual Report of the Regents of the University of the State of New York, 1859.' If you possess this publication, you will find there, at page 59, a memoir of Prof. J. Hall, entitled 'Trilobites of the shales of the Hudson River group.' This *savant* there describes three species under the names *Olenus Thompsoni*, *Olenus Vermontana*, and *Peltura* (*Olenus*) *holopyga*. The well-defined characters of these trilobites are described with the clearness and precision to be expected from so skilful and experienced a palæontologist as James Hall.

"Although the specimens are incomplete, their primordial nature cannot admit of the least doubt, when the descriptions are read, accompanied with wood engravings, which the large dimensions of these three species render sufficiently exact. The first is 105 millim. long by 80 broad, the other two are somewhat smaller.

* Proceed. Boston S. N. Hist., Vol. vii, Dec. 1860, p. 371.

"The heads of the two *Oleni* being injured, the furrows of the glabella cannot be recognized. The thorax has a common and remarkable character, which consists in the greater development of the third segment, the point of which is stronger and longer than in all the other pleura. This is a striking resemblance to the *Paradoxides*, the second segment of which has the same peculiarity. Besides, there is an intimate relation between these two primordial types, and we should not be surprised if America furnished us with forms uniting most of their characteristics. The pygidium of *O. Thompsoni*, the only one that is known, shows no segmentation, and attests by its exiguity its relation to a primordial trilobite. *P. holopyga*, by its whole appearance, resembles the Swedish species so well known by the name of *P. scarabœoides*.

"Thus all the characters of these three trilobites, as they are recognized and described by J. Hall, are those of the trilobites of the primordial fauna of Europe. This is so true, that I think I may say without fear, if M. Angelin, or any other palæontologist practised in distinguishing the trilobites of Scandinavia, had met with these three American forms in Sweden or Norway, he would not have hesitated to class them among the species of the primordial fauna, and to place the schists enclosing them in one of the formations containing this fauna. Such is my profound conviction, and I think any one who has made a serious study of the trilobitic forms and of their vertical distribution in the oldest formations will be of the same opinion.

"Besides, all who have seriously studied palæontology know well that each geological epoch, or each fauna, has its proper and characteristic forms, which once extinct reappear no more. This is one of the great and beautiful results of your immense researches, which have generalized this law, recognized by each one of us within the limits of the strata he describes.

"The great American palæontologist arrived long since at the same conclusion, for in 1847 he wrote the following passage in the *Introduction* to the first volume of the monumental work consecrated to the Palæontology of New York.

"'Every step in this research tends to convince us that the succession of strata, when clearly shown, furnishes conclusive proofs of the existence of a regular sequence among the earlier organisms. We are more and more able, as we advance, to observe that the Author of nature, though always working upon the same plan and producing an infinite variety of forms almost incomprehensible to us, has never repeated the same forms in successive creations. The various organisms called into existence have performed their parts in the economy of creation, have lived their period and perished. This we find to be as true among the simple and less conspicuous forms of the palæozoic series, as in the more remarkable fauna of later periods.'—*J. Hall*, '*Pal. of New York*,' i. p. xxiii."

"When an eminent man expresses such ideas so eloquently, it is because they rise from his deepest convictions. It must then be conceived that Mr. Hall, restrained by the artificial combinations of stratigraphy previously adopted by him, has done violence to his palæontological doctrines, when, seeing before him the most characteristic forms of the *Primordial fauna*, and giving them names the most significant of this first creation, he thinks it his duty to teach us that these three trilobites belong to a horizon superior to that on which the second fauna is extinguished.

"In effect, according to the text of Mr. Hall, the three trilobites in question were found near the town of Georgia, Vermont, in schists which are superior to the true Hudson River group. In his works Mr. Hall does not go beyond indicating the horizon of certain fossils, and no one would think of asking from him a guaranty for such indications. But on this occasion the great American palæontologist thinks it necessary to support his stratigraphical determination by another authority, chosen from the most respectable names in geology. The following is the note which terminates his Memoir.

"'NOTE.—In addition to the evidence heretofore possessed regarding the position of the shales containing the Trilobites, I have the testimony of Sir W. E. Logan, that the shales of this locality are in the upper part of the Hudson River group, or forming a part of a series of strata which he is inclined to rank as a distinct group, above the Hudson River proper. It would be quite superfluous for me to add one word in support of the opinion of the most able stratigraphical geologist of the American continent.'

"Now, when a *savant* like Mr. Hall thinks himself obliged to invoke testimony to guarantee the exactness of the position of certain fossils, it is clear that the determination of this position presents some difficulties.

"In order to understand these difficulties I have consulted the maps and documents relating to the State of Vermont and the country in which the town of Georgia is situated, and although the library of our Geological Society does not contain all that one could wish on this subject, I recognized easily that Georgia is placed in the region where the order of succession of the deposits is the most obscured by foldings and dislocations; so that the position of the schists in question could not have been determined by the incontestable evidence of direct superposition. Besides, the physical appearance of these schists is not that of the rocks constituting the typical group of Hudson River. This is verified by the note of Mr. Hall, for he tells us that Sir W. E. Logan is inclined to make a distinct group of these schists superior to that of the Hudson, and which consequently would crown the whole Lower Silurian division of the continent.

"For the above reasons, the geological horizon on which the three *Oleni* of Georgia were found appears to me, at first view, to have been but doubtfully determined, and in complete opposition to palæontological documents.

"I do not think, then, that I weaken in the least degree the respect and confidence justly inspired by the labors of the American *savants* whose names have just been mentioned, when I ask them in the name of science to make new researches and new studies, that may lead to a final and certain solution of this important question.

"Doubtless, thanks of the progress of our knowledge, we are now no longer bound by the ancient conception of the simultaneous extinction and the total renovation of the faunæ. As for myself, in particular, it would not be possible to accuse me of similar views at the moment when I am publishing the explanation of my doctrine of colonies. But you will perceive that the facts which I invoke in support of this doctrine are far from sustaining the reappearance of a fauna after the extinction of the following fauna, which the three trilobites of Georgia would do, if they had really lived after the deposit of the Hudson River group.

"This reappearance would be still more astonishing, as among the three great Silurian faunæ the second fauna occupies the greatest vertical space and is probably the one which enjoyed the longest existence. Thus, to verify such a reappearance, the most incontestable proofs are required, for such a decision would compel the entire re-formation of one of our most important scientific creeds.

"Yours, very truly,

J. BARRANDE."

In another letter, dated Paris, 14th August, 1860, Mr. Barrande says:—

"You will easily perceive the interest and importance of the question, even if it were only raised on account of the three *Oleni* of Georgia; but it takes it now a much wider field, owing to a letter I have just received from Mr. Billings, official palæontologist of the Geological Survey of Canada, who informs me that he has found lately, in the schists and limestones near Quebec, considered as being the prolongation of those in question in Vermont, nearly one hundred species, almost all new. Twenty-six of these come from a white limestone, and seem to him to be the true representatives of the Primordial fauna, and he cites among them *Conocephalites*, *Arionellus*, *Dikellocephalus*, etc., that is, very characteristic forms of this fauna.

"In another limestone, which is gray, he finds thirty-nine species, all different from the first, and representing, on the contrary, the most distinct types of the second fauna. Finally, the black schists furnish him with *Graptolites*, *Lingulæ*, etc., etc., fossils which at first sight cannot determine a horizon, because they are found upon several Silurian horizons.

"While waiting for these very obscure stratigraphical relations to be disentangled, and without committing in any manner Mr. Billings, who should preserve the independence of his opinion, I may yet express to you my view wholly personal, and of which at this moment I take the entire responsibility. I think, then, that this region of schists and limestones of Vermont, in other words the *Taconic system*, will reproduce in America what took place in England as to the Malvern Hills, and in Spain for the Cantabrian chain,—that is to say the Primordial fauna, after having been disregarded, will regain its rights and its place, usurped for a time by the second fauna.

"You see it is a great and noble question, whose final solution will complete the imposing harmonies existing already between the series of palæozoic faunæ of America and that of the contemporaneous faunæ of Europe, leaving to each the imprint peculiar to its continent.

"I can well imagine, from the position previously taken by our learned American brethren on the subject of the Taconic system, that the final solution of which I speak will not be obtained without debate, and perhaps some wounding of self-love, for some opinions that appear to be dominant must be abandoned.

"But experience has taught me that in such cases the most elevated minds turn always first to the light, and put themselves at the head of the movement of reform. Thus, when in 1850 I recognized the Primordial fauna in the Malvern Hills, where the second fauna only had been found, Sir Henry de la Beche and Sir Roderick Murchison were the first to adopt my views, to which little by little the other official geologists agreed; Edward Forbes ranged himself publicly on my side in 1853 in The Geological Survey, while others still hesitated, until now there is no longer any opponent.

"I think there will be the same experience in America, and that in a few years from this time the opinions of your *savans* will have undergone a great change as regards this question.

"It is a fine opportunity for Dr. Emmons to reproduce his former observations and ideas with more success than in 1844.

"Yours very truly,

J. BARRANDE."

III.

SIR WILLIAM LOGAN'S LETTER TO J. BARRANDE,
Vol. V. page 472, ante.

IV.

LETTER FROM JAMES HALL, PALÆONTOLOGIST OF NEW YORK, TO THE EDITORS OF THE AMERICAN JOURNAL OF SCIENCE AND ARTS.

GENTLEMEN,—In the Twelfth Annual Report of the Regents of the University* upon the State Cabinet of Natural History, I published descriptions of three species of trilobites from the shales of the town of Georgia in Vermont, referring them to the age of the Hudson River group. These trilobites had been in my possession for some two years or more; and knowing the great interest that would attach to them, whenever published, I had waited, hoping that some new facts might be brought out touching the stratigraphical relations of these rocks in the town of Georgia.

* The same to which Mr. Barrande refers in his text to Prof. Bronn, p. 312. The preceding communications sufficiently explain the subject under discussion.

After the descriptions had been printed and a few copies distributed, I learned that Sir William Logan was at that time actually investigating the rocks of that part of Vermont. Desiring to know the results of his latest researches in regard to the stratigraphical relations of these rocks, I withheld the final publication till the meeting of the American Association for the Advancement of Science, in Springfield, and there showed to Sir William my descriptions as they now stand in the report, and I then received his authority for the addition of the note which was appended.

This in a few words is a simple history of the matter relating to the publication of these species. I made no remarks or comparisons with the primordial fauna of Barrande in Bohemia, knowing that these features would be at once recognized by every palæontologist; while their reference to the genus *Olenus* showed my appreciation of the nature of the fossils.

I received a copy of the communication of Mr. Barrande, from Sir William Logan in September, a few days before setting out for my field duties in Wisconsin. Since my return to Albany, constant and pressing occupation has left me no time to consider a reply to a question of so much importance.

Later discoveries in the limestones associated with the shales at Quebec leave no longer a doubt, if any could have been entertained before, that the shales of Georgia, Vermont, are in the same relative position; and we must regard these three trilobites as belonging to the same fauna with the species enumerated by Sir William Logan as occurring in the Quebec group. Left to palæontological evidence alone, there could never have been a question of the relations of these trilobites, which would at once have been referred to the primordial types of Barrande.

Sir William Logan yields to the palæontological evidence, and says, "*there must be a break.*" He gives up the evidence of structural sequence which he had before investigated and considered conclusive; and having heretofore relied upon the opinion of the distinguished geologist of Canada in regard to a region of country to which my own examinations have not extended, I have nothing left me but to go back to the position sustained by palæontological evidence. Let us for a moment examine this palæontological evidence.

The identifications of the fosssils of the Quebec group certainly show a remarkable agreement between the trilobites of this group and those of the Potsdam sandstone, in the occurrence of six species of *Dikellocephalus* and one of *Menocephalus;* while the occurrence of many others is in agreement or not incompatible with the fauna of the Potsdam and Calciferous sandstones. The comparative values' of the trilobitic faunæ of this group and of the primordial zone of Europe, as established by Barrande, is better shown in a tabular form which I here append.

The Crustacean fauna of the primordial zone of Europe.

Paradoxides, -	These genera are all limited to the *primordial fauna*, and none of the other European genera of trilobites are known in this fauna.
Olenus, - -	
Peltura, - -	
Conocephalus, -	
Ellipsocephalus,*	
Hydrocephalus, -	
Sao, - - -	
Arionellus, -	
Agnostus, - -	Of the first and second fauna.
Amphion, - -	Placed with doubt in the first fauna, and is well developed in the second fauna.

The Crustacean fauna of the Quebec Group.

Conocephalus, -	Genera of the *primordial zone.*
Arionellus, -	
Agnostus, - -	A genus passing from the first to the second fauna.
Dikellocephalus, -	Genera of the Potsdam period.
Menocephalus -	
Bathyurus, -	Quebec group.
Asaphus, - -	Of the second fauna.
Illænus, - -	Of the second and third fauna.
Amphion, - -	Of the second fauna; and doubtfully of the first fauna in Sweden.
Ceraurus = Cheirurus,	Of the second and third Silurian faunæ, and of the Devonian fauna.

We have therefore in the Quebec Group, two established genera of the primordial zone; one, *Agnostus*, which passes from the primordial to the second fauna; one, *Amphion*, cited as doubtful in the first fauna in Sweden, and known to be in the second; and three,—*Asaphus, Illænus* and *Cheirurus*, which begin their existence in the second fauna. Of these, Asaphus begins and ends in the second; *Illænus* begins with the second and continues to the third; while *Ceraurus* = *Cheirurus* begins in the second, extends through the third Silurian, and appears in the Devonian fauna.

* Not *Elliptocephalus* of Emmons.

Bathyurus is a new genus, and as yet has no stratigraphical value in comparisons. Those which I described as *Olenus* have proved to be not true *Oleni*, and though much resembling that genus, are nevertheless distinct; I have proposed the name *Barrandia* and *Bathynotus* for the two forms.* These have yet no stratigraphical value, except so far as their relations to established genera may aid in that direction.

The genera *Dikellocephalus* and *Menocephalus* are of the Potsdam group; and so far the Quebec group is in parallelism with the Potsdam and Calciferous strata.

Of the other genera, we know *Asaphus*, *Illænus* and *Ceraurus* (= *Cheirurus*) in the Trenton limestone and Hudson River groups; *Illænus* and *Ceraurus* in the Upper Silurian strata of Niagara age, or the third fauna of Barrande; while *Ceraurus* occurs also in the Devonian of Europe. *Amphion* is known in the second fauna in Europe, and, doubtfully in the first.

Ceraurus does not occur in this country, so far as I know, above the Niagara group, though known in the Devonian rocks of Europe.

The following tabular arrangement of the genera found in the Quebec group will serve to express more distinctly the relations of the crustacean fauna of these rocks.

The letters at the he' ' the columns have the same references as those used in the communication of Sir William Logan.

	A	A^1	A^2	A^3	A^4	B^1	B	B^3
Arionellus	....	—	4	....	....	....	....	....
Conocephalus,	....	—	1	....	....	....	....	....
Agnostus	....	—	3	1	....	....	....	....
Dikellocephalus,	....	—	6	....	....	....	....	....
Menocephalus,	—	1	—	—	—	....	....	....
Bathyurus,	....	—	....	4	1	....	....	1
Barrandia, } *Shales of*	....	....	....	....	....	....	....	....
Bathynotus, } *Georgia, Vt.*	....	....	....	....	....	....	....	....
Amphion,	....	....	....	2	....	....	....	....
Asaphus,	....	1	....	....	1	....	....	1
Illænus,	....	....	....	....	....	....	....	2
Cheirurus (Ceraurus),	....	....	....	2	....	....	....	....
Leperditia,	....	....	....	....	....	....	1	....
Lingula,	2	—	2	....	....	....	....	....
Discina,	....	—	1	....	....	....	....	....
Orthis,	1	—	1	2	1	11	1	3
Leptæna,	....	—	1	1	....	1	....	....
Strophodonta,	....	—	....	1	....	....	....	....
Camarella,	....	....	1	1	1	....	1	....

* Thirteenth Annual Report of the Regents of the University of N. Y., on the State Cabinet of Natural History, Albany, December, 1860.

	A	A^1	A^2	A^3	A	B	B^2	B^3
Cyrtodonta?				1				
Maclurea,								1
Murchisonia,				3				1
Pleurotomaria,				7				2
Helicotoma,				2				1
Straparollus,				2				
Capulus				2				
Ophileta,								1
Nautilus,							1	1
Orthoceras,							1	3 or 4
Cyrtoceras,								1
Crinoidal columns,							3	
Tetradium,	1							
Dictyonema,	3			1				
Graptolithus,	25							
Retiolites,	1							
Reteograptus,	2							
Phyllograptus,	5							
Dendrograptus,	3							
Thamnograptus,	3 [?]							

In this table we find, of previously recognized trilobites of the primordial fauna, two genera and five species; of previously known genera of the second and third faunæ, four genera and eight species; two genera before known in the Potsdam sandstone and seven species; and of *Agnostus*, which is of the first and second faunæ, two species; and one new genus with nine species.

These are certainly very curious results; and a modification of our views is still required to allow four genera and eight species, (or leaving out *Amphion*) three genera and six species of the trilobites of the second fauna to be associated with two genera and five species of trilobites of the primordial fauna, and yet regard the rock as of primordial origin.

The brachiopodous genera, *Lingula, Discina, Orthis, Leptæna* and *Strophomena*, have a great vertical range, and are known in the Lower and Upper Silurian, and most of them in the Devonian; while *Camerella* so far as known is a Lower Silurian form of the second fauna (perhaps also in a lower position).

Of the gasteropoda, *Maclurea* and *Ophileta* are restricted to Lower Silurian rocks, but occur mainly in the second fauna. The other genera occur likewise in the second fauna and in the Upper Silurian rocks as well as some of them in Devonian. The same is true of the cephalopoda enumerated.

Tetradium is known in the second fauna of the Lower Silurian rocks, and in the upper part of the Hudson River group at the west. *Dictyonema* is a genus known from Lower Silurian to Devonian strata.

Graptolithus proper extends to the Clinton group of New York; and the same is true of *Reteograptus*. *Tamnograptus* occurs in the rocks of the Hudson River group near Albany, and in the Quebec rocks. *Phyllograptus* and *Retiolites* are known in the Quebec rocks only; while the typical form of *Dendrograptus* occurs in the Potsdam sandstone, and, likewise, in three other species, in the Quebec rocks.

We find, therefore, in the other genera, except trilobites, very little satisfactory evidence on which to rely in the present state of our knowledge, for determining the position of these strata.

In the present discussion, it appears to me necessary to go further, and to inquire in what manner we have obtained our present ideas of a primordial, or of any successive faunæ. I hold that in the study of the fossils themselves there were no means of such determination prior to the knowledge of the stratigraphical relations of the rocks in which the remains are inclosed. There can be no scientific or systematic palæontology without a stratigraphical basis. Wisely then, and independently of theories, or of observations and conclusions elsewhere, geologists in this country had gone on with their investigations of structural geology. The grand system of the Professors W. B. and H. D. Rogers had been wrought out not only for Pennsylvania and Virginia but for the whole Appalachian chain; and the results were shown in numeous carefully worked sections. In 1843, '44 and '45 I had myself several times crossed from the Hudson River to the Green Mountains, and found little of importance to conflict with the views expressed by the Professors Rogers in regard to the chain farther south, except in reference to the sandstone of Burlington, and one or two other points, which I then regarded as of minor importance.

Sir William Logan had been working in the investigations of the geology of Canada; and better work in physical geology has never been done in any country.

This then was the condition of American geology, and investigators concurred, with little exception, in the sequence based on physical investigations. As I have before said, our earliest determinations of the successive faunæ depend upon the previous stratigraphical determinations. This I think is acknowledged by Mr. Barrande himself, when he presents to us, as a preliminary work, a section across the centre of Bohemia. With all willingness to accept Mr. Barrande's determination, fortified and sustained as it is by the exhibition of his magnificent work upon the trilobites of these strata, we had not yet the means of parallelizing our own formations with those of Bohemia by the fauna there known. The nearest approach to the type of primordial trilobites was found in those of the Potsdam sandstone of the northwest, described by Dr. D. D. Owen; but none of these had been generically identified with Bohemian forms;* and the prevailing opinion, sanctioned as I have understood by Mr. Barrande, was that the primordial fauna had not been discovered in this country, until the re-discovery of the *Paradoxides Harlani*, at Braintree, Mass. The fragmentary fossils published in vol. 1, Palæontology of New York, and similar forms of the so-called Taconic system, were justly regarded as insufficient to warrant any conclusions. It then became a question for palæontologists to decide, whether determinations founded on a physical section in a disturbed and difficult region of comparatively small extent, were to be regarded as paramount to determinations founded on examinations, like those of the Professors Rogers, extending over a distance in the line of strike of five or six hundred miles; and those of Sir William Logan over nearly as great an extent from Vermont to Gaspé.

It is not possible for me, at this moment, to give the time necessary for a full discussion of this important subject. In presenting these few facts in this form, I am far from doing it in the spirit of cavilling, or as an expression of distrust in any direction. It is plain that the case is not met in Mr. Barrande's plan of successive trilobitic faunæ; and the facts yet brought out do not serve to clear up the difficulty. It is evident that there is an important and perplexing question to be determined,—one that demands all the wisdom and sagacity of the most earnest inquirers, and one which calls for the application of all our knowledge in stratigraphical geology and in palæontology;—one in which coöperation, good will and forbearance are required from every one, to harmonize the conflicting facts as they are now presented. The occurrence of so many types of the second fauna in the rocks at Point Levi, associated with a smaller number of estab-

* The glabellæ of small trilobites undistinguishable from *Conocephalus* occur in the Potsdam sandstone near Trempaleau, Wisconsin, on the Mississippi river.

lished primordial types, offers us the alternative of regarding these strata as of the second stage, with the reappearance of primordial types in that era, or of bringing into the primordial zone several genera heretofore regarded as beginning their existence in the second stage: in either case, so far as now appears, conflicting with the scheme of Mr. Barrande in reference to the successive faunæ of trilobites as established in Bohemia and the rest of Europe.

For myself I can say, that no previously expressed opinion, nor any "*artificial combinations of stratigraphy previously adopted*" by me, shall prevent me from meeting the question fairly and frankly. I have not sought a controversy on this point, but it is quite time that we should all agree that there is something of high interest and importance to be determined in regard to the limitation of the successive faunæ of our older palæozoic rocks.

I am, yours, &c.,

James Hall.

Albany, N.Y., Jan. 23, 1861.

ARTICLE VIII.—*Catalogue of Plants collected in the Counties of Argenteuil and Ottawa, in* 1858. By W. S. M. D'Urban.

The following list of Plants contains 362 species, all of which were collected strictly within the Laurentian district, many introduced species growing on the fossiliferous rocks in the immediate neighbourhood of the town of Grenville, being omitted. A large portion were determined by myself on the spot with the aid of Dr. Asa Gray's admirable "Manual of the Botany of the Northern United States," which was my almost constant companion during the five months I spent in the district, but I have to acknowledge my obligations to Mr. G. Barnston, who kindly assisted me in naming some phenogamous species; to Col. Munro, C. B., 39th Regt., who most obligingly determined the whole of the sedges and grasses; to Mr. D. Allan Poe, who examined the cryptogams, and named all the mosses, some of which he submitted to the eminent bryologist, Mr. James of Philadelphia; and lastly to Dr. Dawson for allowing me unlimited access for purposes of reference to the Holmes herbarium deposited in McGill College.

Many of the specimens collected were so small and depauperated in form, from the poverty and scantiness of the soil that I found it very difficult to recognise them at the first glance, and even when compared with specimens gathered in the rich limestone districts, it was with difficulty I could believe them to be the same species, until I had made a very close examination.

A considerable number of European plants were found round clearings, lumber roads, and along the banks of the Rouge, and I have indicated such as were obviously introduced, by an asterisk. (*)

For the sake of brevity I have given the English names of some of the commoner species only, and in general those under which they are known to the settlers and lumbermen. With the assistance of the other members of our party, I was enabled to obtain the Indian names of a few species, and they will be found below, spelled, I believe correctly, in accordance with their pronunciation. They were furnished by the son of the Algonquin chief of the Indian settlement on the Rouge, in the township of Arundel, called "Chi-chick" (pronounced Shes-sheep), who could read and write his own language, and understood both English and French.

I have given the dates at which I found most of the flowering species in full flower, (F.) and their fruit ripe, (F. R.) believing they may be useful in indicating the climate of the district.

When no locality in particular is mentioned the plant was distributed over the whole district.

LONDON, ENGLAND, May 16th, 1860.

Ranunculaceæ (Crowfoot Family).

Clematis Virginiana, Linn. Abundant in swamps; F. 12th August.

Anemone Pennsylvanica, Linn. In great abundance and luxuriance on a clearing near the Devil's rapids on the Rouge; F. 30th June to 18th July.

Thalictrum cornuti, Linn. Abundant in moist places; F. 16th July.

Ranunculus Flammula, Linn., var. reptans. Amongst stones by the water-side, River Rouge, near Silver Mountain; F. 5th August.

" Pennsylvanicus, Linn. Abundant in wet places, Hamilton's Farm; F. 30th June.

" acris, Linn. Clayey banks of the Rouge and round clearings; F. 13th June.

Caltha palustris, Linn. Marshy ground, clearings along Chatham, North Town.

Coptis trifolia, Salisb. Very abundant in rocky woods and swamps; F. 31st May.

Aquilegia Canadensis, Linn. A few stunted plants on gneiss rocks, Sixteen Island Lake; F. 3rd June.

Actæa spicata, Linn., var. rubra, Michx. Abundant in rocky woods; F. R., end of July.

" " var. alba, Michx. Woods near Hamilton's Farm.

Cabombaceæ (Water-shield Family).

Brasenia peltata, Pursh. Abundant in lakes and ponds.

Nymphæaceæ (Water-lily Family).

Nymphæa odorata Ait. Bark Lake, Arundel; F. 17th July.

Nuphar advena, Ait. Abundant in most lakes; F. 28th June.

Sarraceniaceæ (Pitcher-plant Family)

Sarracenia purpurea, Linn. (Ta-na-da-tas, Algonquin). Common in bogs or Beaver-meadows; F. July.

Papaveraceæ (Poppy Family).

Sanguinaria Canadensis, Linn. (Blood root). Clearings on crystalline limestone, Wentworth.

Fumariaceæ (Fumitory Family).

Dicentra Cucullaria, DC. Abundant in woods on crystalline limestone; F. 15th May.

Corydalis glauca, Pursh. Sparingly on gneiss rocks, Sixteen Island Lake and Huckleberry rapids on the Rouge; F. 15th June to 17th July.

Cruciferæ (Mustard Family).

Dentaria diphylla, Linn. (Indian Pepper). Rocky woods; F. 30th May.

Cardamine hirsuta, Linn. A very small form; growing submerged by the sides of the Rouge near Silver Mountain, and in wet places on Hamilton's Farm.

*Capsella bursa-pastoris, Mœnch. Abundant about clearings.

Violaceæ (Violet Family).

Viola rotundifolia, Michx. Locality not noted.

" blanda, Willd. Rich woods, generally on limestone; F. 17th May.

" Selkirkii, Goldie. Gate Lake, Wentworth; F. 17th May.

" cucullata, Ait. Very abundant and luxuriant about the French settlement in Wentworth, also moist places about clearings on Bevin's Lake, Montcalm; F. 4th June.

" Canadensis, Linn. Very abundant and luxuriant, French settlement, Wentworth; F. 4th June.

" pubescens, Ait. Rich low woods on crystalline limestone; F. beginning of June.

Droseraceæ (Sun-dew Family).

Drosera longifolia, Linn. Sphagnum and swamp round a small pond near the Indian Village on the Rouge, and on pine logs in a small lake near Lake of Three Mountains.

Hypericaceæ (St. John's-wort Family).

Hypericum ellipticum, Hook. Sandy banks of the Rouge; F. 14th July to 21st August.

Caryophyllaceæ (Pink Family).

*Silene noctiflora, Linn. Abundant on the clearings, Indian Village, Arundel; F. 16th July.

*Agrostemma Githago, Linn. Amongst wheat, clearing near Bevin's Lake; F. 7th July.

Stellaria borealis (?) Bigelow. Bevin's Lake, Montcalm.

*Cerastium vulgatum, Linn. Common amongst grass at Hamilton's Farm.

Portulacaceæ (Purslane Family).

Claytonia Caroliniana, Michx. (Ground-nut). Very abundant, low, rich woods on limestone; F. 15th May.

Tiliaceæ (Linden Family).

Tilia Americana, Linn. (Bass-wood). Abundant, reaching a large size on alluvial soil and limestone.

Oxalidaceæ (Wood-sorrel Family).

Oxalis Acetosella, Linn. Abundant in rocky woods and swamps; F. 28th June.

* " stricta, Linn. On sand, mouth of the Devil's River, Huckleberry Rapids and Hamilton's Farm.

Geraniaceæ (Geranium Family).

Geranium Carolinianum, Linn. Extremely depauperated on gneiss rocks, Huckleberry Rapids.

Balsaminaceæ (Balsam Family).

Impatiens fulva, Nutt. Abundant in moist places; F. 21st August.

Anacardiaceæ (Cashew Family).

Rhus typhina, Linn. Sparingly and very small about Hamilton's Farm; common about Grenville.

" Toxicodendron, Linn. (Poison ivy). Abundant on rocks and sand; F. R. 3rd August.

Vitaceæ (Vine Family).

Ampelopsis quinquefolia, Michx. Abundant on damp ground in open places.

Sapindaceæ (Soap-berry Family).

Acer Pennsylvanicum, Linn. (Dogwood). Abundant in rocky woods generally on gneiss; F. 13th June.

" saccharinum, Wang. (Hard Maple). Very abundant on all soils, but especially fine on limestone and drift. The young trees compose the greater part of the underwood throughout the distinct.

" rubrum, Linn. (Soft or water maple). Very abundant on low ground along the Rouge, but scarce in other places; F. 25th May.

Leguminoseæ (Pulse Family).

*Trifolium pratense, Linn. Common along the banks of the Rouge and round clearings; F. 30th June.

* " repens, Linn. (White clover). Abundant on the banks of the Rouge and round clearings.

Desmodium Canadense, DC. Huckleberry rapids: F. 3rd August.

Amphicarpæa monoica, Nutt. Common in swamps and along the banks of the Rouge; F. 8th August.

Rosaceæ (Rose Family).

Prunus pumila, Linn. On gneiss and limestone rocks near Mr. Thompson's clearing and at Huckleberry rapids; F.R. 3rd August.

" Pennsylvanica, Linn. Forming dense thickets where White Pine has been destroyed by fire; F. R. 23rd July.

" Virginiana, Linn. (Choke cherry). Occurred sparingly in woods and at Hamilton's Farm.

Spiræa salicifolia, Linn. In profusion everywhere along the shores of the Rouge and lakes; F. 21st July.

" tomentosa, Linn. Sparingly on the margins of small lakes near Hamilton's Farm.

Agrimonia Eupatoria, Linn. Common in open places, damp woods, &c.

Geum album (?) Gmelin. Huckleberry rapids and near Silver Mountain.

Potentilla Norvegica, Linn. Abundant round clearings; F. 18th July.

" arguta (?) Pursh. Banks of the Rouge near Devil's rapids.

" palustris, Scop. Abundant in shallow parts of Chain lake. also observed in Bevin's lake, Montcalm, and growing on gneiss rock by the side of the lake on Silver Mountain.

Fragaria Virginiana, Ehrh. Abundant in open places; F. R. 23rd July.

" vesca, (?) Linn. A large strawberry was growing in great profusion and luxuriance near the French settlement in Wentworth, the specimens collected were lost; F. 4th June.

Dalibarda repens, Linn. Abundant in rock woods; F. 2nd July to August.

Rubus odoratus, Linn. (Scotch-cap). Sparingly Dolan's lake, Grenville and Sugar-bush lake, Montcalm. Abundant about Grenville.

" triflorus, Richardson. Abundant in rocky woods; F. end of May, F. R. 30th June.

" strigosus, Michx. (Wild raspberry). Abundant round burnt clearings, sandy banks of the Rouge, &c.; F. 30th June, F. R. 23rd July.

" villosus, Ait. (Blackberry). Abundant in lumber roads and tamarack swamps near Hamilton's Farm and Indian Village; F. 17th July, F. R. 4th September.

" Canadensis, Linn. Sandy and rocky places, Sugar-bush lake and Hamilton's Farm; F. 28th June.

Rosa blanda, Ait. (Ki-nau-ki-te-me-ka-che, Algonquin). Abundant on the sandy and clayey banks of the Rouge, and on the rocks, Huckleberry rapids; F. 30th June.

Cratægus coccinea, Linn. Sugar-bush lake, Montcalm. Common about Grenville.

Pyrus arbutifolia, Linn. var. erythrocarpa. Gneiss Island, Trembling lake. Var. melanocarpa. Swamp near Hamilton's Farm and Bark lake, Montcalm.

" Americana, DC. (Rowan or Mountain Ash). Common in rocky woods.

Amelanchier Canadensis, Torr. & Gray. var. Botryapium (Indian Pear). Abundant on gneiss rocks in open places; F. 31st May, F. R. 11th July.

Onagraceæ (Evening-primrose Family).

Epilobium angustifolium, Linn. (Fire-weed). Very abundant on burnt clearings and along the clayey banks of the Rouge; F. 16th July.

" coloratum, Muhl. Sandy banks of the Rouge near Silver Mountain.

Œnothera biennis, Linn. Very abundant; sandy shores of the Rouge and Bevin's lake; F. 19th July to 21st August.

" pumila, Linn. On sand, Bevin's lake, near Thompson's clearings and Devil's rapids; F. 8th July.

Circæa alpina, Linn. In profusion in low damp woods, on fallen trees, &c.; F. 28th June.

Grossulaceæ (Currant Family).

Ribes Cynosbati, Linn. (Wild gooseberry). Abundant in rocky woods; F. R. 7th August.

" lacustre, Poir. Abundant in swampy woods; F.R. 3rd August.

" prostratum, L'Her. (Musk currant). Common in rocky woods; F. 31st May.

" rubrum, Linn. Abundant round clearings; F. R. 18th July.

Saxifragaceæ (Saxifrage Family).

Mitella nuda, Linn. Abundant amongst moss at the roots of trees in moist woods; F. 19th June.

Tiarella cordifolia, Linn. Very abundant in rocky and sandy woods.

Chrysosplenium Americanum, Schwein. Abundant in rocky streams; F. 25th May.

Umbelliferæ (Parsley Family).

Sanicula Marilandica, Linn. Portage to Bark lake, Huckleberry rapids and amongst grass at Hamilton's Farm.

Cicuta bulbifera, Linn. Borders of a small lake near Hamilton's Farm and a muddy creek near Trembling Lake.

Sium lineare, Michx. Borders of a small lake near Hamilton's Farm.

Osmorrhiza brevistylis, DC. Common in open woods and round clearings.

Araliaceæ, (Ginseng Family.)

Aralia racemosa, Linn. (Spigot) Common in open places on alluvial soil; F. 20th July to 21st August, F. R., 7th September.

" hispida, Michx. Abundant in burnt clearings, Hamilton's

Farm, and on Trembling Mountain; F. R. 28th August.

Aralia nudicaulis, Linn. (Sarsaparilla.) Very abundant everywhere, except on sand, F. 13th June, F. R. 29th July.

" trifolia, Gray. Rocky woods, Sixteen Island Lake.

Cornaceæ, (Dog-wood Family).

Cornus Canadensis, Linn. Abundant in rocky woods; F. 20th June.

" circinata, L'Her. On limestone rocks, Huckleberry rapids.

" stolonifera, Michx. (Red Osier). In profusion on shores of the Rouge and Lakes; F. 30th June.

" alternifolia, Linn. (Green Withy). Sparingly on alluvial soil in woods.

Caprifoliaceæ, (Honey-suckle Family).

Linnæa borealis, Gronov. Very abundant in woods; F. 30th June.

Lonicera ciliata, Muhl. Abundant in rocky woods; F. 30th May, F. R. 30th June.

Diervilla trifida, Mœnch. Very abundant in open places on rocks and sand; F. 27th June.

Sambucus Canadensis, Linn. (Elder.) Round clearings and open places, on limestone and alluvial soil.

" pubens, Michx. Abundant in rocky woods; F. R. 17th July.

Viburnum Lentago, Linn. Not seen below Silver Mountain, but common there and everywhere above, especially on Trembling Mountain; F. R. 11 June.

" Opulus, Linn. (High-bush Cranberry.) Sparingly near water, Sugar-bush Lake, and banks of the Rouge near Silver Mountain; F. 25th June.

" lantanoides, Michx. (Mozo-mish, Algonquin. Welsh Hopple.) Very abundant, forming a large part of the underwood in rocky woods; F. 30th May.

Rubiaceæ, (Madder Family).

Galium asprellum, Michx. Abundant in low swampy ground.

" trifidum, Linn. Open sandy places, about clearings, &c.

" triflorum, Michx. Abundant in open sandy places, banks of the Rouge and Sugar-bush Lake.

Mitchella repens, Linn. (Ke-na-pe-ko-bug, Algonquin, Partridge berry.) In profusion in rocky woods; F. 17th July, F. R. 9th August.

Compositæ, (Composite Family).

Eupatorium purpureum, Linn. (Ka-bis-sak-wan-nith-que-ok, Algonquin). Abundant, reaching a height of six feet in swampy places, but much stunted when growing on rocks; F. 9th August.

Aster corymbosus, Ait. Abundant in lumber roads near Hamilton's Farm.

" macrophyllus, Linn. Common in rocky and sandy woods, and open places; F. 4th August.

Aster longifolius ? Linn. On sand at the base of Silver Mountain; F. 10th August.

" puniceus, Linn. Growing in dense clumps in swampy ground; F. 25th August.

" acuminatus, Michx. Common on rocks at Huckleberry Rapids and Silver Mountain, F. 9th August.

" nemoralis, Ait. In profusion on gneiss rocks on the shores of Trembling Lake; F. 7th September.

Erigeron Canadense, Linn. Open fields amongst grass, Hamilton's Farm.

" Philadelphicum, Linn. Moist clay bank of the Rouge, Arundel; F. 30th June.

" strigosum, Muhl. On sand at the mouth of the Devil's River, and common at Hamilton's Farm; F. 21st July.

Diplopappus umbellatus, Torrey and Gray. In great profusion on the sandy banks of the Rouge, and on the shores of lakes; F. August.

Solidago latifolia, Linn. Common on sandy banks by the water side; F. 12th August.

" (undetermined). Abundant everywhere along the Rouge on rocks and sand.

" altissima, Linn. (Golden-rod.) Very common on rocks and sandy banks of the Rouge.

" nemoralis, Ait. Abundant on sandy banks of the Rouge.

" lanceolata, Linn. Abundant on sandy banks of the Rouge.

* Achillea Millefolium, Linn. (Yarrow). Abundant on sandy banks of the Rouge; F. 21st July.

* Lucanthemum vulgare, Linn. In great abundance round clearings and on the banks of the Rouge.

* Tanacetum vulgare, Linn. About settlements in Grenville and Wentworth.

Gnaphalium polycephalum, Michx. Common in open places and very abundant at Hamilton's Farm, amongst grass in the fields.

Antennaria plantaginifolia, Hook. On gneiss rocks, Huckleberry Rapids, and on a small mountain near Silver Mountain.

* Cirsium lanceolatum, Scop. About clearings at Bevin's Lake, and Hamilton's Farm.

" muticum, Michx. Swamp near Hamilton's Farm; F. 2nd September.

* " arvense, Scop. (Canada Thistle). About clearings at Bevin's Lake and Hamilton's Farm.

Hieracium Canadense, Michx. Common on rocks and sand; F. 9th August.

Nabalus albus, Hook. Abundant on rocks and sand banks, in open places; F. 19th August.

* Taraxacum Dens-leonis, Desf. (Dandelion). Common near clearings and along portage paths.

Mulgedium leucophæum, DC. Common about clearings and open places on sandy soil.

Lobeliaceæ, (Lobelia Family).

Lobelia inflata, Linn. Common, lumber roads and open fields, Hamilton's Farm.

Ericaceæ, (Heath Family).

Vaccinum Oxycoccus, Linn. Tamarack swamp near Hamilton's Farm.

" macrocarpon, Ait. (Mas-ki-ki-min, Algonquin, Cranberry). Bog or Beaver Meadow near Indian Village, Arundel; F. 16th July.

" Canadense, Kalm. Abundant on gneiss rocks and in swamps; F. 15th June, F. R. 23d July.

Chiogenes hispidula, Torr. & Gray. (Indian Tea). Abundant in rocky and sandy woods and swamps, amongst moss; F. R. 25th August.

Epigæa repens, Linn. Common on sand and gneiss rocks amongst pines near Hamilton's Farm.

Gaultheria procumbens, Linn. (Low-bush Cranberry). Very abundant in woods and bogs, especially among young trees; F. August and September.

Cassandra calyculata, Don. Shores of lakes and in swamps; F. 18th May.

Andromeda polifolia, Linn. Tamarack swamp in Wentworth and near Indian Village; F. 13th June.

Kalmia angustifolia, Linn. (Wi-sa-ke-bug, Algonquin). On gneiss rocks and in swamps; F. 17th July.

Ledum latifolium, Ait. (Labrador Tea). Abundant on gneiss rocks and swamps in open places; F. 20th June.

Pyrola rotundifolia, Linn. (Ka-kis-ke-bok). Abundant, especially at Huckleberry Rapids, amongst young poplars; F. 23rd July.

" secunda, Linn. Common in rocky woods; F. 9th July.

Chimaphila umbellata, Nutt. (Prince's Pine). Abundant in open pine woods; F. 23rd July.

Monotropa uniflora, Linn. (Anay-moos-she-moos-ki-ki, Algonquin, said to mean the little-dog's-pipe). Common in woods, especially on rocky hills; F. 25th July to 11th September.

" Hypopitys Linn. Occasionally met with in damp woods; F. 7th July to 20th August.

Aquifoliaceæ, (Holly Family).

Ilex verticillata, Gray. On gneiss rocks and swamps in open places; F. 17th July, F. R. 7th September.

Nemopanthes Canadensis, DC. (Mau-ko-ke-me-che, Algonquin). Common on gneiss rocks, and in swamps; F. R. 16th August.

Plantaginaceæ, (Plantain Family).

* Plantago major, Linn. Abundant about Hamilton's Farm.

Primulaceæ, (Primrose Family).

Trientalis Americana, Pursh. (Ground Cherry). Abundant almost everywhere; F. 25th June.

Lysimachia stricta, Ait. Very abundant by water side, in low place all along the Rouge; F. 7th August.

Lentibulaceæ, (Bladder-wort Family).

Utricularia vulgaris? Linn. Abundant in a small lake near Hamilton's Farm.

Scrophulariaceæ, (Fig-wort Family).

* Verbascum Thapsus, Linn. Clearings near Indian Village and Hamilton's Farm; F. 16th July.

Chelone glabra, Linn. Common on sand banks by water side, and in swamps; F. 16th August.

Mimulus ringens, Linn. Shores of the Rouge near Thompson's clearing.

Ilysanthes gratioloides, Benth. In great abundance on exsiccated places, Hamilton's Farm.

Veronica scutellata, Linn. On sand, in a few places, by side of the Rouge.

Labiateæ, (Mint Family).

Mentha Canadensis, Linn. Abundant in low places along the Rouge; F. 9th August.

Lycopus Virginicus, Linn. In profusion on sand by water side and on rocks; F. 5th August.

Brunella vulgaris, Linn. Common about clearings and lumber roads; F. 18th July.

Scutellaria galericulata, Linn. Abundant everywhere along the Rouge, and low places by streams; F. 9th August.

" lateriflora, Linn. Equally abundant with the last species in the same places.

* Galeopsis Tetrahit, Linn. Abundant about clearings near Devil's Rapids and Hamilton's Farm.

Borraginaceæ, (Borage Family).

* Cynoglossum officinale, Linn. A little in open places, Huckleberry Rapids.

Gentianaceæ, (Gentian Family).

Gentiana Andrewsii, Griseb. Common on sand by sides of the Rouge, shores of lakes and swamps; F. 5th August to 11th September.

Menyanthes trifoliata, Linn. Bog near Indian Village, Arundel.

Apocynaceæ, (Dog-bane Family).

Apocynum androsæmifolium, Linn. Common in open sandy places and on rocks; F. 10 July.

" cannabinum, Linn. Abundant on sand banks by the side of the Rouge; F. 18th July.

Asclepiadaceæ, (Milk-weed Family).

Asclepias incarnata, Linn. (To-to-cha-na-bo-wakn, Algonquin). Exsiccated places near Indian Village; F. 18th July.

Oleaceæ, (Olive Family).

Fraxinus Americana, Linn. (White Ash). Abundant in woods, reaching a large size especially on drift; bare of leaves 7th October.

" sambucifolia, Linn. (Black Ash). Common in low ground by water side.

Aristolochiaceæ, (Birthwort Family).

Asarum Canadense, Linn. (Wild Ginger). In a few places on low sandy flats.

Chenopodiaceæ, (Goose-foot Family).

* Chenopodium album, Linn. (Lamb's Quarters). Abundant about the Indian Village and Hamilton's Farm.

Polygonaceæ, (Buck-wheat Family).

* Polygonum Persicaria, Linn. Abundant about the house at Hamilton's Farm.

" aviculare, Linn. Abundant with the last species.

" sagittatum, Linn. Damp places in woods near Hamilton's Farm.

" cilinode, Michx. Common, open places, borders of woods, &c.

Rumex —— ? I observed a tall Dock growing by the side of the Rouge near Silver Mountain but was unable to obtain a specimen.

* " Acetosella, Linn. (Sheep's Sorrel.) Abundant about clearing and old portage paths.

Thymeleaceæ (Mezereum Family.)

Dirca palustris, Linn. (Che-ba-cub, Algonquin;) Moose-wood. Abundant in woods on all soils; F. 22d May.

Urticaceæ (Nettle Family.)

Ulmus Americana, Linn. (White Elm.) Abundant and reaching a large size on gneiss, limestone and drift.

Laportea Canadensis, Gaudich. Growing in dense beds on low alluvial soil; F. 1st July.

Juglandaceæ (Walnut Family.)

Juglans cinerea, Linn. (Butternut.) Abundant on sandbanks near the Indian Village and Sugar Bush Lake.

Cupuliferæ. (Oak Family.)

Qercus alba, Linn. (White Oak.) Some very fine trees at Sugar-bush and Bevin's Lakes, Montcalm, on alluvial soil.

Fagus ferruginea, Ait. (Beech.) Generally distributed through the woods, but most abundant on gneiss forming splendid Beech Woods in the Township of Wentworth.

Corylus rostrata, Ait. (Wild Nut.) Abundant in moist open places.

Ostrya Virginica, Willd, (Iron wood.) Sparingly on alluvial soil Sugar-bush and Bevin's Lakes.

Myricaceæ (Sweet-gale Family.)

Myrica Gale, Linn. Abundant on the shores of Lakes and in Swamps: F. 24th May.

Betulaceæ (Birch Family.)

Betula papyracea, Ait. (Canoe Birch.) Numerous in some places along the Rouge above the Indian Village and sparingly distributed through the woods, being seldom of large size.

" excelsa, Ait. (Yellow Birch.) Abundant and generally distributed.

Alnus incana, Willd. (Alder.) Forming dense thickets on the shores of all the rivers and lakes. Very tall on rocks at Huckleberry Rapids.

Salicaceæ (Willow Family.)

Salix candida? Willd. A little on alluvial soil, Sugar-bush Lake.

" discolor, Muhl. Sugar-bush Lake, Montcalm and Mouth of Devil's River.

" sericea, Marshall. Mouth of Devil's River on sand.

" longifolia. Muhl. Sugar-bush Lake, common.

" lucida, Muhl. Banks of the Rouge, abundant.

Populus tremuloides, Michx. (Aspen.) Grows to a large size on alluvial soil and is common.

" grandidentata, Michx. (Common Poplar.) Forms with the last species and white birch dense thickets of young trees where other trees have been removed, grows to a good size in some places.

" . balsamifera, Linn. (Balsam Poplar.) A few fine trees at Sugar-bush Lake and small bushes up Devil's River and Huckleberry Rapids.

Coniferæ (Pine Family.)

Pinus resinosa, Ait. (Norway Pine.) On limestone and gneiss islands, Trembling Lake, and gneiss ridge; Lake of Three Mountains,

" Strobus, Linn. (White Pine.) The greater part of the White Pine of any size has been removed in this district, but a few pine trees are scattered here and there on all kinds of soil. Numerous at Hamilton's Farm on sand, small trees are numerous on gneiss hills.

Abies balsamea, Marshall. (Balsam Fir.) Not very abundant, on sand.

" Canadensis, Michx. (Hemlock.) Abundant, reaching a large size, and often growing on bare rocks.

" alba, Michx. (Spruce.) Very abundant on gneiss hills and sand.

Larix Americana, Michx. (Tamarack.) Forms extensive "tamarack swamps," and scattered trees are found in every variety of situation.

Thuja occidentalis, Linn. (Cedar.) Forming extensive "cedar swamps, and pinging the shores of all lakes.

Taxus baccata, Linn. var. Canadensis (Ground Hemlock.) Abundant, especially in low sandy woods.

Araceæ (Arum Family.)

Arisæma triphyllum, Torr. (Indian Turnip.) Common in moist woods; F. 2d June.

Acorus Calamus, Linn. Sandy banks of the Rouge.

Typhaceæ (Cat-tail Family.)

Typha latifolia, *Linn. Up the Devil's River in one place only.*

Sparganium simplex, Hudson. Muddy creek near Huckleberry Rapids; F. 31st July.

Naiadaceæ (Pondweed Family.)

Potamogeton (undetermined.) Abundant in the Rouge, in quiet places.

Alismaceæ (Water-plantain Family.)

Sagittaria variabilis, Engelm (Mo-sa-ka-ta-mo, Algonquin; Arrow-head.) Abundant in muddy creeks and lakes, and along the Rouge; F. 29th July.

Orchidaceæ (Orchis Family.)

Platanthera *orbiculata, Lindl. (Heal-all.) Abundant in woods;* F. 3rd. July.

" dilatata? Lindl. Observed in several places in the woods; F. 15th July.

" fimbriata, Lindl. Abundant in low swampy grounds; F. 19th July.

Goodyera pubescens, R. Brown. Abundant in rocky and sandy woods; F. 20th August.

Pogonia ophioglossoides, Nutt. Numerous in bogs near Indian Village; F. 16th July.

Calopogon pulchellus, R. Brown. Numerous in bogs near Indian Village; F. 16th July.

Microstylis ophioglossoides, Nutt. Dry hills, Huckleberry Rapids.

Cypripedium pubescens, Willd. (Moccason Flower.) Near Lake St. Jean, Wentworth: F. 13th June.

" acaule, Ait. On gneiss rocks and sand, common; F. 16th June.

Iridaceæ (Iris Family.)

Iris versicolor, Linn. Abundant, shores of the Rouge and lakes; F. 26th June.

Smilaceæ (Smilax Family.)

Smilax herbacea, Linn. Mouth of the Devil's River, on sand, climbing over bushes.

Trillium erectum, Linn. Abundant in rocky woods; F. 18th May.

" var. album, Purch. On limestone, between Gate and Gut Lakes, Wentworth.

" grandiflorum, Salisb. Townships of Grenville and Wentworth, not seen beyond Gate Lake; F. 25th May.

" erythrocarpum, Michx. *Abundant in rocky woods; F.* 31st May.

Medeola Virginica, Linn. Very abundant in rocky and sandy woods; F. 21st June, F. R. 2d September.

Liliaceæ (Lily Family.)

Polygonatum biflorum, Ell. Common in moist woods; F. 29th May.

Smilacina racemosa, Desf. (Au-que-co-ce-wa, Algonquin, meaning Chip-nambo berries.) Abundant in rocky woods; F. 19th June.

" stellata, Desf. On sand by water-side, not common; F. 20th June.

Clintonia borealis, Raf. Very abundant everywhere in woods; F. 16th June.

Allium tricoccum, Ait. (Chi-kwa-kwich, Algonquin, said to mean it makes a bad smell.) Abundant in moist places in woods; F. 17th July.

Erythronium Americanum, Smith. Abundant in rich woods; F. 22d May.

Melanthaceæ (Colchicum Family.)

Uvularia grandiflora, Smith. Abundant by road-sides in cleared parts of Grenville; F. 14th May.

Streptopus amplexifolius, DC. In great abundance in moist places in woods; F. 2d July.

" roseus, Michx. (Squaw-root.) Abundant in rocky woods; F. end of May.

Juncaceæ (Rush Family.)

Juncus articulatus, Linn. Abundant on sandy banks of the Rouge.

" tenuis, Willd. Hamilton's Farm.

" bufonius, Linn. Hamilton's Farm.

Pontederiaceæ (Pickerel-weed Family.)

Pontederia cordata, Linn. Very abundant in small lakes near Lake of Three Mountains and in sheltered shallow parts of Trembling Lake.

Eriocaulonaceæ (Pipewort Family.)

Eriocaulon septangulare? Withering. Trembling Lake, Lake of Three Mountains, &c.

Cyperaceæ (Sedge Family.)

Dulichium spathaceum, Pers. Swampy ground near Hamilton's Farm.

Eleocharis palustris, R. Brown, (Spike-rush.) In pools of water on rocks, Huckleberry Rapids.

Scirpus sylvaticus, Linn. var. atrovirens (Bulrush.) Abundant sandy banks of the Rouge.

" Eriophorum, Michx. In pools of water on rocks, Huckleberry Rapids.

Eriophorum Virginicum, Linn. (Cotton grass.) Boggy margins of small lakes near Hamilton's Farm.

Carex tenella, Schk. Abundant, growing in water, Sugar-bush Lake, Montcalm.

" scoparia, Schk. Abundant, on sandy banks of the Rouge.

" festucacea, Schk. Sandy banks of the Rouge and Bevin's Lakes, Arundel.

Carex crinita, Lam. Abundant in moist places and borders of streams in woods.
" pedunculata, Muhl. In rich woods on limestone between Gate and St. Jean Lakes, Wentworth.
" arctata, Boott. On alluvial soil, Sugar-bush Lake, Montcalm.
" lacustris, Willd. With the last species.
" intumescens, Rudge. With the two last species.
" retrorsa, Schw. Sugar-bush and Bevin's Lakes, Montcalm.

Gramineæ (Grass Family.)

*Phleum pratense, Linn. (Timothy.) Abundant round clearings and sandy banks of the Rouge.
Agrostis perennans, Tuckerm. Sandy banks of the Rouge.
" vulgaris, With. (Red-top grass.) Everywhere in open places and about clearings.
Cinna arundinacea, Linn. var. pendula. Sandy banks of the Rouge.
Muhlenbergia Mexicana, Trin. Abundant on sandy banks of the Rouge.
Calamagrostis Canadensis, Beauv. Abundant about the Indian Settlement and in open places.
Poa serotina, Ehrh. Open places, Huckleberry Rapids.
" pratensis, Linn. (Common Meadow-grass.) Abundant about Indian Village and other clearings.
Bromus ciliatus, Linn. Abundant, sandy banks of the Rouge, and in moist woods.
Elymus Canadensis, Linn. In moist places along lumber roads.
Milium effusum, Linn. On alluvial soil, Sugar-bush Lake, Montcalm.
Panicum microcarpon, Muhl. On sand banks, sides of the Rouge.
" pauciflorum, Ell.? Huckleberry Rapids.
" depauperatum, Muhl. Huckleberry Rapids.

Equisetaceæ (Horse-tail Family.)

Equisetum pratense, Ehrh. Abundant, wet sandy banks of the Rouge.
" sylvaticum, Linn. With the last species.
" limosum, Linn. Abundant in shallow water at the mouths of creeks and sides of the Rouge.
" hyemale, Linn. Sparingly in numerous localities throughout the district, common at Hamilton's Farm.
" scirpoides, Michx. Amongst mosses on gneiss rocks in woods.

Filices (Ferns.)

Polypodium vulgare, Linn. Principally on gneiss rocks, very abundant.
" Phegopteris, Linn. Very abundant in damp woods.
" Dryopteris, Linn. Abundant in rocky woods.
Struthiopteris Germanica, Willd. Abundant in low swampy ground in woods.

Allosorus gracilis, Presl. On crystalline limestone near the Lake of Three Mountains.

Pteris aquilina, Linn. Abundant amongst White Pine and in open places.

Adiantum pedatum, Linn. In small patches on limestone and garnetiferous gneiss.

Asplenium thelypteroides, Michx. Rare. In rich woods, De Salaberry West Town Line.

" Filix-fœmina, R. Brown. Very abundant in moist woods.

Dicksonia punctilobula, Hook. Abundant in damp woods, in Harrington, and near Hamilton's Farm.

Woodsia Ilvensis, R. Brown. On rocks on a hill, near Silver Mountain.

Cystopteris bulbifera, Bernh. Abundant on damp limestone rocks in woods near Huckleberry Rapids, and Lake of Three Mountains.

" fragilis, Bernh. On gneiss rocks, base of Silver Mountain, and near Lake of Three Mountains.

Aspidium Thelypteris, Swartz. Damp woods.

" spinulosum, Swartz. Everywhere abundant.

" cristatum, Swartz. Bevin's Lake, Lake of Three Mountains, and near Hamilton's Farm.

" Goldianum, Hook. Abundant amongst gneiss rocks, near Hamilton's Farm.

" marginale, Swartz. Abundant on gneiss rocks everywhere.

" aculeatum, Swartz, var. Braunii, Koch. Abundant on gneiss rocks and on damp logs.

" acrostichoides, Swartz. Sparingly in various localities.

Onoclea sensibilis, Linn. In dense patches in low swampy ground.

Osmunda regalis, Linn. var. spectabilis. Abundant, borders of streams, and swampy places.

" Claytoniana, Linn. Abundant in swampy places.

" cinnamomea, Linn. Swampy places near Bevin's Lake.

Botrychium Virginicum, Swartz. Abundant in open places, Huckleberry Rapids and Hamilton's Farm.

Lycopodiaceæ (Club-moss Family.)

Lycopodium lucidulum, Michx. Sixteen Island Lake.

" dendroideum, Michx. Abundant in rocky woods.

" clavatum, Linn. Abundant in rocky and sandy woods.

" complanatum, Linn. Common in woods.

Musci (Mosses.)

Sphagnum cymbifolium, Dill. Forming the bogs called Beaver-meadows.

" acutifolium. Ehrb. On gneiss rocks in open places.

Dicranum interruptum, Br. and Sch. On boulders near Bevin's Lake.

" scoparium, Linn. On gneiss rocks on a small mountain near Silver Mountain.

" Drummondii, Mull. Near Sugar-bush and Balsam Lakes Montcalm.

Dicranum Scottianum, Turn. (Fert.) Sixteen Island Lake, Montcalm.

Leucobryum glaucum, Hampe. In large clumps on gneiss rocks amongst pines. Sixteen Island Lakes.

Polytrichum commune, Linn, (Fert.) Abundant in wet places and on moist rocks.

" *formosum, Hedw. Near Chain Lake, Montcalm.*

" juniperinum, Hedw. (Fert.) Near Chain Lake, Montcalm, and on gneiss hills on the Rouge.

Bryum roseum, Schreb. Abundant everywhere in woods.

" Wahlenbergii, Schreb. (Fert.) Wet clayey places in woods and clayey banks of the Rouge, Arundel, 30 Tune.

Mnium affine, Bland. On decayed logs near Chain and Sugar-bush Lakes, Montcalm.

" hornum, Hedw. Chain Lake, Montcalm and Huckleberry Rapids, De Salaberry.

" orthorhynchum, Brid. (Fert.) Huckleberry Rapids, De Salaberry, July.

" punctatum, Hedw. Abundant in streams and wet places.

" Drummondii, Br. and Sch. (Fert.) On limestone between Gut and Gate Lakes, Wentworth.

" spinulosum, Bry. Europ. Near chain Lake, Montcalm.

Bartramia pomiformis, Hedw. (Fert.) Abundant on both gneiss and crystalline limestone rocks, near Lake of Three Mountains.

" fontana, Brid. On limestone rocks near water, Huckleberry Rapids.

Funaria hygrometrica, Hedw. (Fert.) On rocky places which have been burnt over; in great abundance.

Fontinalis Frostii, Sulliv. Abundant in a stream running into Sixteen Island Lake.

Dichelyma capillaceum, Bry. Europ. On dead sticks in water Sugar-bush Lake.

Anomodon obtusifolius, Br. and Sch. Abundant everywhere on trunks of trees.

Platygyrium repens, Bry. Europ. On tree trunks, decayed logs, &c. Sugar-bush Lake.

Neckera pennata, Hedw. (Fert.) Abundant on trunks of growing cedars.

Climacium Americanum, Brid. Abundant in wet places in woods.

" dendroides, Web. and Mohr. By the sides of streams in woods, Montcalm.

Hypnum triquetrum, Linn. (Fert.) Everywhere in woods on the ground and fallen trees.

" splendens, Hedw. Very abundant with the last species.

" Schreberi, Willd. Abundant in woods on gneiss hills.

" fluitans, Linn. Bevin's Lake, Montcalm.

" Crista-Castrensis, Linn. Very abundant in damp woods.

Hypnum reptile, Michx. (Fert.) Mixed with *Platygyrium repens* on decayed logs, &c., Sugar-bush Lake.

" curvifolium, Hedw. (Fert.) Sugar-bush Lake, &c., Montcalm.

" Haldanianum, Grev. On boulders, near Bevin's Lake, Montcalm.

" rutabulum, Linn. Chain Lake, Montcalm.

Hepaticæ (Liverworts.)

Marchantia polymorpha, Linn. (Fert.) Everywhere round burnt clearings on the ground.

Fegatella conica, Corda. In damp woods on mosses, Sugar-bush Lake, and on limestone rocks in woods near Huckleberry Rapids.

Jungermannia —— ? Abundant on tree trunks.

Trichocolea Tomentella, Nees. Hamilton's Farm.

Lichenes (Lichens.)

Usnea barbata, Fr. var. pendula. Everywhere hanging from the branches of the conifers.

Petigera aphthosa, Hoffm, (Infert and Fert.) Pine woods near Thompson's clearing.

" polydactyla, Hoffm, (Fert.) Common in woods on mosses

Sticta pulmonaria, Ach. (Tripe-de-Roche.) Pine woods, near Thompson's clearing.

Parmelia caperata, Ach. Abundant on trunks of pine and stones.

Cladonia pyxidata, Fr. (Fert.) (Cup-lichen.) Abundant on stumps and decaying trees.

" gracilis, Fr. (Fert.) (Red cup-lichen.) Everywhere on decaying logs and stumps.

" furcata, Floerk. (Fert.) Pine woods near Thompson's clearing.

" rangiferina, Hoffm. (Rein-deer Moss.)

" " var. sylvatica Fl. On a gneiss hill in woods.

" " var. alpestris, Fl. Abundant on rocks in open places.

Umbilicaria hirsuta, Ach. On a gneiss hill near Silver Mountain.

Agaric.

Clavaria (probably C. fragilis. Destroyed in drying.) Very abundant, covering the ground for many yards, September 18th., woods near Lake of Three Mountains.

NOTE.—This Catalogue was completed in the summer of 1859, and a copy containing much more elaborate notes than those above, which I transmitted for publication at the beginning of February last by the Steamer "Hungarian," was lost on board that unfortunate vessel.

LONDON, May 16, 1860.

ARTICLE IX.—*Notes on the Geology of Murray Bay—Lower St. Lawrence.* By J. W. DAWSON, LL.D., F.G.S.

(Read before the Natural History Society.)

Fig. 2.
Coast near L'Ecorché. See p. 141.

Murray or Mal Bay on the north side of the River St. Lawrence, and about 90 miles below Quebec, is well known as a place of resort to summer tourists and sea bathers, and has not been unvisited by geologists. In 1822, Dr. Bigsby, one of the earliest explorers of Canadian geology, and still in his green old age a prominent member of the Geological Society of London, spent a few days at this place, and published a most interesting and graphic account of its topography and geology, in Silliman's American Journal.* In 1831, Capt. Baddely published in the Transactions of the Literary and Historical Society of Quebec, an account of the neighbouring Bay of St. Paul, with a notice of the earthquakes which appear to visit this district more frequently than any other part of Canada.† In 1849 the steps of our Provincial geologist were directed thither, in consequence of a fabulous report of the discovery of coal at Bay St. Paul; and a short but clear and accurate account of the structure of this part of Canada appeared in the Report of the Survey for that year. Learning from these previous observers, that the locality is of much geological interest, I determined in visiting it for a few days in the past summer, to pick up such gleanings as my prede-

* Vol. 5, 1822.

† Quebec Transactions, vol. II. See also paper by the author on the earthquake of 1860. Can. Nat., vol. 5.

cessors might have left, and in this I was greatly aided by one of my students, Mr. R. Ramsay of Montreal, who happened to be spending his vacation there.

The features of the place have been admirably described by Dr. Bigsby and Sir W. E. Logan, so that a very few remarks on this subject may suffice here. In approaching the bay from the west, the voyager passes along the base of lofty cliffs crowned by forests and broken by a few wooded ravines, down which little brooks dash to the shore. Near the termination of this wall of cliffs, and at the base of a steep ascent leading to a gap separating the last outlier of rock from the main mass, stands the steamboat pier. Ascending the rising ground above the pier, and passing to its northern side, one sees in the foreground a row of cottages extending along the western side of the bay, whose waters at high tide rise close to the low bank, and when they recede leave an immense flat of sand and boulders, across which stretch the long brush weirs of the fishermen. Beyond are seen the sides of the bay rising into terraced hills and converging toward the mouth of the Murray Bay River, where concealed by trees are the church and village of Mal Bay; and still farther the eye can trace the deep valley of the river winding among high wooded hills, that rise one over another in the blue distance. It is a beautiful spot, well worthy of taking a leading place among the summer resting places of our worn and wearied citizens.

The general geology of Murray Bay may be thus sketched. The higher hills consist of rocks of the *Laurentian System*, the oldest strata known to geologists; and in some places as at the high cliffs before mentioned, and at Cape Heu on the opposite side of the bay, these come boldly down to the shore. In other places the coast cliffs and reefs are *Lower Silurian*, and abound in marine fossils, and these beds in some places mantle the hills to a considerable height, and run a long way up the valley of the river. The terraces of sand and gravel along the sides of the bay, and the deep clay of the river valley, are of *Post Pliocene* date, and contain shells identical in species with those now living in the Gulf of St. Lawrence. I shall notice these formations in their order.

1. *Laurentian System.*

These venerable rocks, ancient above all others, are admirably exposed in the coast cliffs above mentioned, and in several other places in the vicinity of the bay, but they present a strange and puzzling aspect to the observer. Proved by the investigations of Logan and Hunt, to have once been sedimentary rocks, they have been so changed by heat and chemical action, that they retain no resemblance to the sands, clays, and limestones, of which they were originally composed. They now appear as beautifully crystalline layers, which have when in a yielding and flexible condition, been bent and crumpled as if for long ages they had been kneaded by the hands of Titans, so that it is difficult to form any conception either of their original nature or arrangement. The greater number of rocks are eloquent to the geologist of the history of life in past periods of the earth, but these Laurentian beds preserve an obstinate silence, only hinting in their flakes of graphite and their crystalline limestones, that they have a story which they cannot be persuaded to tell. Still they afford very instructive examples of the changes which may be effected by *metamorphism* in aqueous sediments, and they abound in interesting and curious crystallized minerals. In the high cliff commencing immediately west of the pier, they are well exposed; and at this place the order of succession is as follows, apparently in ascending order, though these beds are here so often inverted that little reliance can be placed on apparent superposition.

1. Gneiss of various colours and qualities, with both lime and potash felspars, and containing beds of mica slate, with large nodules of garnet, around which the beds bend as if the garnets had originally been foreign masses or pebbles. In some places these beds hold bands or dykes of a coarse-grained red felspar. These gneissose beds are of great thickness and occupy the greater part of this long range of cliffs. They reappear on the opposite side, at and beyond Cape Heu.

2. White quartz rock, perfectly compact, with thin bands of hornblendic and micaceous schist, and in the upper part with some crystals of flesh-coloured felspar. This bed or a similar one appears on the opposite side of the bay on both sides of Cape Heu, where in one place it immediately underlies the Silurian beds, as has been observed by Sir W. E. Logan, but it is clearly a member of the Laurentian series.

3. Impure crystalline dolomite, and light-coloured laminated serpentine. These are only a few feet in thickness, and in some places seem reduced to a few inches. Being the softest part of these rocks, they form a depression in the cliff or reef, and are often hidden by gravel or rubbish.

4. Gneiss as before.

5. Black hornblendic slate with films of mica on the planes of cleavage or bedding.

On the opposite side of the bay the gneiss rises into the high and rugged promontory of Cape Heu, in which a great thickness of this rock is exposed, presenting a succession of hard angular ridges, and having its strike nearly in the direction of the shore or S. 25° W. (see Fig. 1). Cape Heu rises through Silurian limestones which appear on both sides of it and inland. On the west side after an interval occupied by the Silurian beds, the gneiss reappears with a high dip to the N. W., and containing thick veins of red felspar. In tracing it along the shore it becomes nearly horizontal,

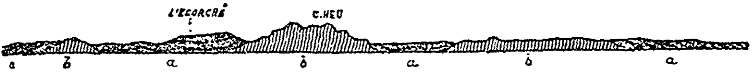


Fig. 1.

(a) *Silurian.* (b) *Laurentian.*

and then dips to the north, and finally becomes vertical and much contorted. Here it contains a vein or bed of coarse grained granite. Next appear mica and hornblende slates, the former with garnets and having a strike S. 20° W. to S. 30° W : then after a space of 150 yards without section, white quartz rock 45 feet thick, and in a vertical position, and succeeding this gneiss with bands apparently of crystalline limestone 4 feet, coarse crystalline dolomite and serpentine 10 feet, and gneiss 4 feet; after which these rocks are concealed by the Silurian beds, resting on them unconformably.

Westward of Cape Heu the quartz rock again appears, and seems here to overlie the gneiss, and no other beds appear between it and the Silurian rocks, which here appear in great mass, forming the conspicuous cliff of L'Ecorché. West of this, and toward Cape Baleine, the shore runs nearly in the junction of the Laurentian and Silurian, the alternate appearance of which at the several points and capes, gives a confused appearance to the coast section, increased by the fact that the Silurian beds are bent into an anticlinal fold near the junction, and that dislocation and denudation have moulded the Laurentian into such irregular forms. Fig. 2 represents a portion of the shore looking east. The Silurian rocks are shaded and appear in the foreground, in a reef dry at low water, and in the cliff of L'Ecorché. The Laurentian forms irregular masses in the middle ground, and Cape Heu presents its bold front in the distance.

2. *Silurian System.*

These rocks rest unconformably on the old gnarled Laurentian beds, and are here sandy in the lower part, simulating the appearance of the Potsdam sandstone, seen in a similar position further west. A little higher they assume the aspect of Calcareous sandstones, and these are overlaid by limestones capped by dark calcareous shales. We thus have a series which at first sight might be supposed to be a miniature representation of the whole lower Silurian of Canada, from the Potsdam sandstone to the Utica slate. According to Mr. Billings, however, the fossils of these beds belong to the middle part of this series, between the Chazy limestone and Trenton limestone, so that here the older members of the Lower Silurian series either do not occur or are represented only by a few feet of sandstone, nearly destitute of fossils. This corresponds with a conclusion arrived at by Sir William Logan, as the result of very extensive observation, that in the early part of the Silurian period, the old Laurentian shore running along the north of Canada was sinking beneath the sea, which was gradually carrying the newer deposits further and further up its sides, so that the older beds are often concealed from view. The subsidence must have been greater in some places than in others, or the upper deposits have in some places been more removed by subsequent denudation, for while in the middle of Canada near the confluence of the Ottawa, the series is complete, both to the westward and eastward the older members of the Silurian series are concealed. I was much struck with this lately at Madoc in Upper Canada, where the junction of hard slaty rocks of the Laurentian series with a Lower Silurian limestone is well seen. The latter under the limestone presents a shattered and weathered surface that must have long endured the action of the elements. while the limestone, a mass of fragments of shells and corals, contains irregular fragments of the older rock, and has filled up the crevices of the latter with whole and broken Orthoceratites, and other shells, which lie just as the wave threw them in. It requires scarcely any imagination in such a place to fancy one's self standing on the old Laurentian shore, and watching the bright billows hurling their load of shells and fragments against the shore, and year by year reaching higher and higher on the land,

and covering more and more of it with the spoils of the sea. In such a place the geologist longs to find some indication of the inhabitants of that early land. What trees rustled in the breezes that blew over that ancient sea? What animals roamed along the coast to feed on the dead cuttle-fishes as they were thrown on shore? No fragment of leaf or bone has yet told any tale of them. To find such remains would be a strange and startling discovery. Not to find them, is in some sense stranger still, for with so long a range of Lower Silurian shore as exists in Canada, it almost implies that the old Laurentian land was void and desolate, that in penetrating backward into geological time, we have reached a land and a period in which no creative fiat had gone forth to people the dry land. But we must not yet believe this on merely negative evidence, and must still search for the remains of such primeval life.

But to return to Murray Bay, the Silurian rocks are well seen at L'Ecorché, the section at which place has been given in some detail by Sir W. E. Logan. They are repeated on the coast east of Cape Heu, and are also seen on the west side of the bay inside the pier, near Little Mal Bay, and in various places on the hill sides, and on the Murray Bay River. From all these exposures, the following series of beds may be ascertained. The names of the fossils are given as determined by Mr. Billings, who has kindly examined them, and the series is descending.

I. Black bituminous flaggy limestone and shale, not rich in fossils. This is best seen at the cove east of Pt. Heu, and in places on the west side of the bay. The following fossils were collected, principally at the former place, *Orthis testudinaria*, *Conularia trentonensis*, *Discina*, n. s., *Serpulites*, n. s., *Graptolithus*, *Straparollus*, *Orthoceras*.

II. Gray and black limestone in thin uneven layers, and often coarse and sandy. It abounds in fossils and is well exposed some distance east of Cape Heu, also in the cliff at L'Ecorché, and in various places on the west side of the bay. The following fossils were collected. They are mostly species characteristic of the Trenton limestone.

Stenopora fibrosa.	*Bellerophon bilobatus.*
Receptaculites Neptuni.	*Murchisonia.*
Glyptocrinus.	*Orthoceras Murrayi.*
	Cyrtoceras?
Orthis pectinella.	

Strophomena alternata.
Leptaena sericea.
Ambonychia radiata.
Modiolopsis nasuta.
Cyrtodonta, n. s.
Trinucleus concentricus.
Asaphus platycephalus.
Bronteus lunatus.
Calymene Blumenbachii.
Encrinurus.
Dalmanites.

III. Hard arenaceous limestone and calcareous sandstone. This forms the greater part of the cliff at White Point, immediately within the pier, and the lower part of the high cliff at L'Ecorché. It is less distinctly seen east of Cape Heu. The sand in these beds is beautifully rounded as if by long attrition on the shore, and occasionally there are pebbles giving some beds the character of conglomerate. The following fossils were found, but the hardness of the beds rendered it impossible to procure perfect specimens.

Stenopora fibrosa.
Columnaria alveolata.
Petraia.
Glyptocrinus.
Vanuxemia Montrealensis.
Pleurotomaria staminea.
P————
Orthoceras Bigsbyi.
O——— *recticameratum.*
Illaenus globosus.

IV Thin bedded and somewhat nodular dark gray limestone. Best seen at L'Ecorché; also east of Cape Heu, and in the cliff inside the pier, at the base near the west side. This bed abounds in *Leperditia*, apparently *L. amygdalina* and another species. It also contains *Strophomena alternata*, *Modiolopsis nasuta*, and a *Pleurotomaria*.

V. Hard gray quartzose sandstone with calcareous cement and bands of coarse sandy limestone. At L'Ecorché, also east of Cape Heu, in the cliff inside the pier, and at Little Mal Bay on the beach. The fossils are

Tetradium fibratum.
Lingula eva. N. s.
Rhynconella.
Pleurotomaria.
Murchisonia.

VI. Soft gray and dark gray laminated sandstone, seen at most of the places above mentioned. The gap through which the road passes upward from the pier, has been excavated in these soft beds. In the lower part of these beds there appears in one or two places a layer of coarse calcareous sandstone, holding fragments of the Laurentian quartz rock. This lowest bed at Pt. Baleine contains large specimens of *Orthoceras*, probably *O. Bigsbyi.* The soft sandstones abound in cylindrical marks, seemingly casts of worm tracks. They also contain fragments of carbonaceous matter, probably the remains of sea weeds. The only shells found in them were small fragments of *Lingula*, and a little *Pleurotomaria*, which may either belong to a new species or be a young individual of one already known.

The following is a detailed section of the lower part of the above series as it occurs in the east side of L'Ecorché. The order is *ascending*, or the reverse of that in the foregoing general summary.

Laurentian Series.—The upper part of this, at this place, is the quartz rock before mentioned, with a high dip to the westward. It rests on gneiss, and in the bank or cliff is seen to have the Silurian beds unconformably superimposed.

Silurian Series.—These dip W. 10° N., or nearly in the same direction with the Laurentian rocks, at an angle of 10°, and consist of the following beds:—

	ft.	in.
(1.) Gray and dark gray sandstone with worm burrows, thickness estimated	12	0
(2). Flaggy calcareous sandstone with a dark bed containing fucoids? at top	5	0
(3.) Softer sandstone with dark coloured bands, very fucoidal in upper part	4	6
(4.) Hard calcareous sandstone	2	0
(5.) Coarse sandy limestone light gray, with many large *Lingulae* (*L. cra*, Billings) and *Tetradium*	0	4
(6.) Gray and dark sandstone with worm burrows and fucoids; *Murchisonia*, *Tetradium* and *Pleurotomaria*	7	0
(7.) Hard gray sandstone divisible into thin flags	2	0
(8.) Thick bedded calcareous sandstone	4	0
(9.) Dark gray calcareous sandstone, *Murchisonia* and *Tetradium*,	1	0
(10.) Similar bed but very coarse	0	6
(11.) Hard gray limestone, *Murchisonia* and *Pleurotomaria*	1	10
(12.) Hard gray brecciated or nodular calcareous sandstone	5	0
(13.) Thin bedded, nodular dark gray limestone full of *Leperditia*	5	0

(14.) Similar limestone, *Leperditia* less numerous, also *Strophomena* and *Modiolopsis*........................... 6 0

(15.) Hard arenaceous limestone and calcareous sandstone, with little vermicular cylinders in one bed, and fragments of *Pleurotomaria*, &c., entire........................... 20 0

The above bed belongs to the lower part of division 3, of the previous general section, and above it there appears in the cliff a considerable thickness of similar beds capped by the beds of division 2, with some of the Trenton fossils enumerated in the list attached to that division........... 60 feet or more.

When these Silurian rocks were deposited, the older Laurentian series must have been much in its present state. It formed a broken and indented coast lower than the present shore; but its beds were as hard and crystalline, and perhaps as much contorted as they now are. The sea beat against it as now, and this for a very long time; for the deposition of the Silurian sandstones was slow, as is evidenced by the thoroughly rounded grains of sand of which many thick beds are composed, and which indicate the toil of the waves for long ages on the Laurentian shore, first, in breaking up its hard masses, then in grinding these fragments and polishing them into perfectly rounded forms. In the sandstones of some later formations, as for instance in the carboniferous system, the grains are usually angular, but in the Lower Silurian, (and in conversation with Sir Wm. Logan, I find that he has elsewhere observed this appearance,)time has been given carefully to round and polish every grain. In modern times we see such purely silicious and polished sands only on clean beaches, where few remains of plants or animals are allowed by the waves to remain, and perhaps this is connected with the absence of land remains in these old beds. I had at first suspected from the forms of these grains of quartz, that they might be concretionary like those in some green-sand deposits, but microscopic examination shows that they are not of this character, and discloses among them occasional grains of felspar and other minerals in the same rounded condition.

The Silurian beds are not themselves undisturbed. They rise sometimes with steep dips up the sides of the hills, and have been thrown into anticlinal ridges. At one place near Little Mal Bay, they run in a vertical position along the shore parallel to the older series. Here at high tide nothing is seen but the cliff of Laurentian rock, but at low tide a wide shore covered with boulders is laid bare, and stretching along this are seen the edges of the vertical Silurian beds, which have been cut down to the sea level, while their sturdier Laurentian neighbours tower above them in a precipice 200 feet high, (Fig. 3.) On the sides of the bay the Silurian beds in some places reach up the sides of the hills to a

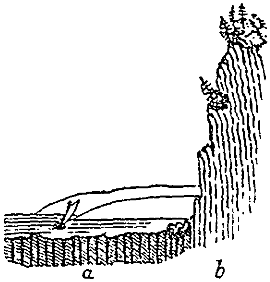


Fig. 3.
Section near Little Mal Bay.
(*a*) Lower Silurian.
(*b*) Laurentian.

height of 300 feet, and they are seen here and there in the valley of the Murray Bay River, as far as the lakes whence it flows. In some places rugged and wasted patches of them are seen clinging to the sides of the Laurentian steeps, just as they have been left by the waves of the receding sea when it last took its departure from the land, at a comparatively modern period of geological time.

From the date of the Lower Silurian to the later tertiary period, embracing by far the greater part of the earth's geological history, at Murray Bay, as in many other parts of Canada, no geological records remain. We therefore next turn to the

Post-Pliocene Deposits.

On the west side of the bay, the Silurian rocks of White Point, immediately within the pier, and which have already been so often mentioned, form a steep cliff, in the middle of which is a terraced step marking an ancient sea level. At the end nearest the pier the sea has again cut back to the old cliff, leaving merely a narrow shelf; but toward the inner side this shelf rapidly expands into the sandy flat along which the main road runs, and which is continuous with the lower plain extending all the way to the head of the bay. In this flat the upper portion of the *Pleistocene* deposit seems to consist principally of sand and gravel, resting on stony clay. In the former, which corresponds to the Saxicava sand of Montreal, I found only a few valves of *Tellina Groenlandica*, which is still the most abundant shell on the modern beach. In the latter, corresponding to the Leda clay, which is best seen in some parts of the shore at low tide, I found a number of deep water shells of the following species, all of which except *Spirorbis spirillum* and *Aphrodite Groenlandica* have been found in these deposits at Quebec and Montreal.

Fusus tornatus.
Trophon scalariforme.
Margarita helicina.
Pecten Islandicus.
Tellina proxima.
Saxicava rugosa.
Aphrodite Groenlandica.
Balanus Hameri.
Spirorbis spirillum,
Serpula vermicularis.

These shells imply a higher beach than that of this lower flat, which is not more than 30 feet above the present sea level. Accordingly above this are several higher terraces, the heights of which on the west side of the bay I measured roughly with a pocket level. The second principal terrace, which forms a steep bank of clay some distance behind the main road, is 100 feet in height, and is of considerable breadth, and has on its front in some places an imperfect terrace at the height of 77 feet. It corresponds nearly in height with the shoulder over which the road from the pier passes. Upon it in the rear of the property of Mr. Du Berger, is a little stream which disappears under ground, probably in a fissure of the underlying limestone, and returns to the surface only on the shore of the bay. Above this is a smaller and less distinct terrace 132 feet high. Beyond this the ground rises in a steep slope, which in many places consists of calcareous beds, worn and abraded by the waves, but showing no distinct terrace ; and the highest true shore mark which I observed, is a narrow beach of rounded pebbles at the height of 326 feet. This beach appears to become a wide terrace further to the north, and also on the opposite side of the bay. It probably corresponds with the highest terrace observed by Sir W. E. Logan, at Bay St. Paul, and estimated by him at the height of 360 feet. These two principal terraces at Murray Bay, correspond nearly with two of the principal shore levels at Montreal, as noticed in my former paper on the *Post Pliocene* deposits,* in which it will be seen that in various parts of Canada, two principal lines of old sea beaches occur at about 100 to 150 feet, and 300 to 350 feet above the sea, though there are others at different levels. To these I have now to add an observation made last summer at Upton, in the Eastern Townships, where I saw in a cleft of the limestone quarried there for copper ore, a deposit of comminuted mussel shells, and entire valves of *Tellina Groenlandica*, *Saxicava rugosa*, and *Mya arenaria*, lying just as the surf drove them into the fissures of this old reef, when the sea stood more than 300 feet above its present level. Guyot remarks in his late paper on the Appalachian mountain system,† that a depression of 140 feet would convert the whole of New England, and the eastern part of Lower Canada into an island; so that when the sea stood at the level of this highest beach at Murray Bay, the hills of New England, of the Eastern Townships, and of Gaspé, formed a long rocky island, separated from the similar masses of hills to the west and south-west, by straits 30 fathoms deep, and all the plain of the St. Lawrence was a sea with but a few rocky islets projecting from it here and there. These stupendous changes belong to the later geological history of Canada, and its re-elevation into dry land belongs to the beginning of the modern period of geology. In the valley of the Murray Bay River, there are evidences of less important but interesting processes attending this re-elevation of the land.

In the *Pleistocene* period the valley of the river has been filled, almost or quite to the level of the highest terrace, with an enormously thick mass of mud and boulders, washed from the land and deposited in the sea bed during the long periods of newer *Pliocene* and *Pleistocene* submergence. Through this mass the deep valley of the river has been cut, and the clay, deprived of support and resting on inclined surfaces, has slipped downward, forming strangely shaped shelves, and outlying masses, that have in some instances been moulded by the receding waves, or by the subsequent action of the weather, into conical mounds, so regular that it is difficult to convince many of the visitors to the bay that they are not artificial. Sir W. E.

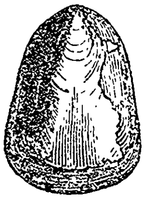
* Canadian Naturalist, Vol. II.
† Silliman's Journal.

Logan in his report above referred to, has in my view given the true explanation of these mounds, which may be seen in all stages of formation on the neighbouring hill sides. Their effect to a geological eye is to give to this beautiful valley an unfinished aspect, as if the time elapsed since its elevation had not been sufficient to allow its slopes to attain to their fully rounded contour; but this appearance is no doubt due to the enormous thickness of the deposit of *Post-pliocene* mud, to the uneven surfaces of the underlying rock, and possibly also in part to the earthquake shocks which have visited this region.

My subject in this paper has been the geological history of Murray Bay, but its modern natural history is not without attraction. Its varied surface and formations afford a copious flora. Its abundant sea weeds have been already noticed in this Journal by Mr. Kemp. The beautiful white porpoises that sport in its waters, and a variety of interesting fishes may be well studied here. The marine invertebrates are not very abundant, and the rocky nature of the bottom and rapid tidal current, render dredging difficult and dangerous, but many interesting forms characteristic of the upper ranges of the St. Lawrence estuary occur. Even the ethnologist may find something interesting in the peculiarity, of a colony of Scotsmen, isolated by the neglect of their countrymen, and changed in the course of two generations, in language, manners, and religion, into French Canadians.

Description of the new species of Lingula referred to in the foregoing paper. By E. Billings.

Lingula Eva.—(Billings.)



Description.—Shell from 1 to $1\frac{1}{4}$ inch in length, greatest width near the front margin, thence gradually tapering with nearly straight sides until within one fourth of the length from the beak, from which point the sides rapidly converge to the beak; apical angle about 90°; both valves rather convex along the middle, thence descending with a flat or gently convex slope to the sides and front margin. Surface with distinct sub-imbricating concentric ridges and fine striæ, and when partially exfoliated obscure longitudinal striæ are visible.

The width at one fourth the length from the beak is usually one fourth less than it is at one sixth the length from the front margin. The following are the measurements of a specimen of the ordinary form.

Length, 12½ lines.

Width at 3 lines from beak, 6½ lines.

Width at 2 lines from front, 9 lines.

The largest specimen found measures nearly one inch and a half in length.

The proportions vary somewhat in different individuals. The species is about the size of *L. quadrata* but differs therefrom in being narrowed from the front upwards.

Formation and Locality.—Murray Bay; in rocks which appear to represent the Black River formation.

Collector.—This fine species was discovered by Dr. J. W. Dawson.

REVIEWS AND NOTICES OF BOOKS.

The limits of exact science as applied to History.—An inaugural lecture delivered before the University of Cambridge, by the Rev. C. Kingsley, M.A., Professor of Modern History.

Mr. Kingsley. the well known and truly distinguished author of Alton Locke, Hypatia, Westward, Ho! and other works of fictitious literature, has lately been appcinted to succeed, in the chair of Modern History in the University of Cambridge, the late justly esteemed and eminent thinker and critic Sir James Stephens. That he will fill this chair with honor to himself and to the University is not doubted by those who are acquainted with the historical character and philosophical tendency of his numerous and delightful writings. He belongs to that school of men in the Church of England, now known as the "Broad Church," and his name has long been associated with liberal ideas of religion, politics and education. He has always been forward to promote as well to advocate the education of the people in the highest and best sense of that term. Along with Maurice and Ruskin he has taken an active part in conducting the studies of the Working Men's College, and now that his zeal and abilities have obtained, we believe from the imperial government, a position which, in modern times, is regarded by its fortunate possessors with just pride, we may expect from his pen works of a more mature and, it may be, of a better order of literature than any he has yet published. This inaugural lecture is a promise of what may be expected from him in the course of his historical prelections. To the phenomena of human life in all its complex relations he would apply, as a method of investigation, the principles of strict induction as opposed to the methods of theory and abstract philosophy. He plainly opposes himself to the apparent tendency of modern scientific philosophy, which aims at reducing social life and progress to the rank of phenomena which are the result of fixed and inevitable laws. Our author insists on the limitation of the idea of law, so justly applicable to the exact or physical sciences, in its application to historical questions. In the treatment of these he would introduce the higher factors of an all-pervading providence and a moral free agency in man. While he recognises in social life, as well as in physical phenomena, order and progress, he yet regards these as results not so much of fixed and inevitable laws as of a direct divine agency and the moral affections of individual men. In history he would search for effective rather than final causes, is content to see God working everywhere without impertinently demanding of him a reason for his deeds, he would have students to study in a frame of mind equally removed from superstition on the one hand and necessitarianism on the other. He fears not to confess natural agencies, but neither is he afraid to confess those supernatural causes which underlie all existence, save God's alone. This lecture is admirable as well for its lucid and profound thought as for its plain common sense.

The Life of William Scoresby, M.A.; D.D., F.R.SS.L. and E., &c.—By his nephew, R. E. SCORESBY JACKSON, M.D., &c. London: T. Nelson & Sons. Montreal: B. Dawson & Son.

This book has been compiled from an autobiographical sketch of the early days of the subject of it, written in the Greenland seas between the years 1821 and 1823, interspersed with brief annotations by the author. The object of the book is to place concisely before the reader the history of one who was remarkable for singular activity of mind and acute observation, who in early life, enlarged the sphere of his scientific researches by repeated voyages, was the first to make an accurate survey of the east coast of Greenland, who penetrated further into the arctic seas than any of his contemporaries; a philosopher whose acute intellect embraced some of the subtlest subjects of physical science. Dr. Scoresby was the first to draw renewed national attention to arctic exploration. His volumes published in the early part of the century on the arctic regions were esteemed at the time of the highest value both in the departments of Geography and Natural History. That, however, for which the subject of this memoir is so justly celebrated is his researches and discoveries in magnetism. To the last he continued to be a zealous investigator into the phenomena of this subtle and curious force. To his labours we are indebted for most valuable improvements in the Mariner's Compass. The Admiralty Compass was the fruit of his unrequited genius, and but for an act of meanness on the part of the Admiralty board, should have been called the "Scoresby Compass." To the position and arrangement of the Compass in iron ships, he devoted the latter days of his life, and by a series of beautiful experiments demonstrated the magnetic character of such ships leaving little more to be desired for the practical purposes of navigation. After spending several years in the Greenland whale fishery, Dr. Scoresby took orders in the Church of England, and was successively Chaplain of the Mariner's Church, Liverpool, Vicar of Bradford and lecturer in Upton. His piety was deep and sincere. A zealous philanthropist, he devoted his time and attainments for the public good. His life is one of singular and pleasing interest, and its history is told with simplicity, truthfulness and affection.

Manual of Modern Geography, Mathematical, Physical and Political, on a new plan, embracing a complete development of the river systems of the globe.—By the Rev. Alex. Mackay, A.M., F.R.G.S. Wm. Blackwood & Sons, Edinburgh. B. Dawson & Sons, Montreal.

"The Manual is marked by the prominence it gives to the *physical* geography of our globe. The *second* part is wholly devoted to this, and very ably executed. It gives a general view, with valuable tables of the chief elements, of the physical aspects and constituents of the world at large. But the physical geography of every particular country is also fully given, and in close connection with the *political*, or rather intermingled with it. But perhaps the characteristic feature in the plan is *the full development of the river system*, and the giving all the towns in connection therewith. It is but lately that this has been even partially attempted, and in no other work is it more than imperfectly, and to a limited extent, carried out. In this manual it is exhibited in singular completeness,—in the minutest details, and to the widest extent. The river basins of every country are given, the area of the basin, and the length of the principal river,—all the tributaries of this river, with their affluents, and, along with this, every city and town of any considerable size and note. The fullest attention is bestowed on all the prominent aspects and objects of the several countries. In no work that we have seen is this done in a way so interesting and elaborate. We would specially notice what is said as to the *coast lines and the lakes*. But, next to the river systems, the mountain systems are most fully developed. The great mountain ranges, with all their ramifications, are delineated with such fulness and distinctness, that one is made to feel as if from some lofty attitude he were gazing down upon them as with eagle vision.

The various sciences specially connected with geography are, in all their bearings on it, elaborately considered,—as geology, mineralogy, botany, zoology, climatology, and ethnography. Most valuable tables are given, setting before us at one view the classes, species, number, &c., of the various objects embraced in these sciences. In particular, ethnography, a most interesting science, but generally all but overlooked in such manuals, has received elaborate attention, and we are presented with all the important results of the latest researches.

Political geography, we have said, is given in its connection with the *physical*, and the two branches are thus made to throw light on each other. Statistical tables of singular value are numerous, giving, in briefest space and clearest view, the area and population of the continents, and of the several countries and kingdoms, with their capitals. To a very full and distinct delineation of the political divisions of each country, descriptive notes, many and rich in interesting information, are appended. We have seen nothing that gives in the same brief space so clear and full a view of the eminent names in all branches of literature and science as is here given in the literary lists respecting the various countries. Statistical information of every kind is amply given.

Such is something of the plan in its leading features, and it is evidently such as to recommend the Manual strongly to our notice.

The *execution* is very able. The work is everywhere clear and comprehensive: lucid order, and terse statement, and minute detail, prevail throughout. All is very condensed but very distinct. Every topic embraced by the science is more or less fully noticed, and set in the clearest light. It is not a hasty compilation, but a work of vast labour and research. A scientific mind of high order is everywhere apparent, selecting and disposing in scientific form all the materials.

The *information* conveyed is more minute, full, and varied than we have seen in any book of the kind. We enlarge not on this, it will be manifest to any one competent to judge, who even slightly examines the Manual.

And the *most recent* information is given on every topic. We have the latest researches, discoveries, conclusions, of those most qualified to inform and guide us."—*Witness, Edinburgh.*

The cost and size of this book will prevent it from coming into general use in this country, nor does it give that prominence to Canadian Geography which is necessary for us. Many of its statements, too, concerning Canada, are incorrect and could not be taught in our schools. Excellent as this Manual is, it convincingly proves the urgent necessity of such a Canadian Geography as that now in course of publication by Mr. Lovell of Montreal.

Transactions of the Philosophical Institute of Victoria.

Wherever Britain extends her colonies, some offshoots of her noble scientific institutions springs up to bear testimony to the energy and intelligence of her sons. We have just received through the kindness of Dr. McAdam, the honorary secretary, vols. 2nd, 3rd, and vol. 4, part I of the Journal above named. The Institute has its seat in Melbourne, a city of mushroom growth, but exhibiting all the solid fruits of British civilization. Its Transactions are admirably and even sumptuously printed and illustrated, and are filled with articles on the progress of science and the arts, and of geographical discovery in Australia. The number of short articles stating important new facts, is a very creditable feature, which we wish could be imitated here. We select for insertion one of these, principally because its subject is an interesting part of American ethnology. It is illustrated by a plate characteristically printed in gold, and which we regret that we cannot reproduce.

"The present time furnishes ample illustration of the influence gold has had in extending civilization and promoting the rapid populating of previously desert regions.

Gold, as the representative of material wealth, has always exercised a powerful influence on the actions of mankind. It is, therefore, highly interesting as well as instructive, to observe the effects produced on the natives of the wilderness by the first discovery of this metal; and it is worthy of especial note that it served a most important purpose in arousing the dormant intellectual faculties, and calling into activity the inventive genius of the untutored savage. In fact, gold and copper have, in different parts of the globe, served a most important purpose in awakening the first sparks of genius, and inducing efforts to obtain some of the benefits these metals confer on those who, by their ingenuity could turn them into articles of utility or ornament.

The history of the gradual advance in civilization of barbarous tribes shows us, among other important facts, that where no metals were found by the inhabitants, improvements in domestic conveniences were very limited; and, we also find that the discovery of metals gives the first impulse towards an early civilization. By further attention we shall likewise find that, to a certain degree, moral improvements were stimulated or retarded as the material progress of the people advanced, retrograded, or remained stationary.

Gold, we have reason to believe, was, in many parts of the world, the first metal brought into use. This was the case in South America. As soon as this valuable metal was known to be easily liquified by strong heat, it may be presumed that the desire of producing some articles of fancy as ornaments was excited. Then the first casting of some simple trinket was made. In such rude and clumsy castings we have the first proofs of this metal being applied to technical purposes, and also the first step in early civilization. It is true that the use of gold by the aboriginal inhabitants of South America was the indirect cause of much suffering to them, as their valuable massive ornaments excited the cupidity of their invaders; but the effects of the early use of this metal were of considerable value to the nation long before the disastrous invasion by the Spaniards.

Copper, also, came under notice; as, like gold, this metal is found in a native or metalic state; but, owing to the comparative scarcity of copper in some localities where gold was plentiful, the former was held in higher estimation than the latter, in consequence of certain improvements obtained by an alloy of copper and gold.

These two metals were the only ones we have any knowledge of having been discovered in that part of the continent comprising the elevated districts and table lands of the Andes, from the Atlantic Ocean to the borders of the empire of Peru, which, at the time we speak of, was in a flourishing state. To obtain the necessary heat for fusing gold, a furnace and a blast were found to be requisite; accordingly we find the very simple plan was adopted of making an excavation in the ground, and coating it with clay. In the centre some stones were placed as a fire-place; charcoal was then ignited, and the smelting pot, with the gold, placed. The heat of the burning charcoal was then increased to the required degree by a certain number of men supplying air by alternatety blowing through long canes, protected at the ends with clay, so as to produce a constant blast in imitation of a double bellows.

The original inventors made the patterns and the moulds for their castings in the following primitive but effective manner. The beeswax having been used to make toys, in the form of reptiles and other animals, for the amusement of children, these insignificant playthings were afterwards used to reproduce, in gold, what they had imitated in wax. The fancy article of wax was, therefore used as a pattern; it was imbedded in clay, a small orifice in the mould being left, made also with wax, through which the melted metal could be introduced. These moulds were then carefully dried in the sun, and afterwards gradually heated so as to melt the wax, and leave the clay-casing or mould ready to receive the fluid metal. This simple and ingenious contrivance of the original inhabitants of South America was also used to procure more elaborate imitations of the flora and fauna of Mexico and Peru.

The Spanish conquerors reached the interior of South America in the year 1545, the northern portion of which they called "Capatania de la Nueva Granada." This included the coast land between the Gulf of Darien and the Cape de la Hacha, reaching the first degree north latitude. The interior part of this Spanish colony occupied a considerable extent of the region of the Andes, the inhabitants of which were represented as a "timid and quiet people." The gold trinkets we have alluded to were here, as elsewhere, used for ornaments by the chief or cacique, as well as the community in general, though a distinct class of ornaments seems to have been reserved for the chiefs. The principal object of the new visitors was gold, which was eagerly sought for in any form, Glass beads, and articles made of iron or steel, which were great novelties to the Indians, were readily bartered in exchange for their gold ornaments. There were, however, some ornaments they were very unwilling to part with; such as images of the chief and his wife in a sitting posture, made of gold, about ten inches high, and 16 ounces weight, and some other imitations of various animals, which were used as ornaments in the dwellings of the chiefs, and were regarded as superior articles of art. These were the cause of the first attack on the property of the inhabitants. In revenge for the outrages they suffered from their oppressors, when gold ornaments became scarce, they refused to show where they obtained this metal in its natural state.

The ornaments obtained by the first visitors being regarded merely as articles of commerce, they were mostly melted into ingots, so that very few of those specimens of early art remained; but as they were in the habit of burying some of their ornaments in the tombs of the caciques, and as some of these burial-places are occasionally discovered, samples of these ancient ornaments have been secured, which furnish interesting illustrations of the first attempt in this branch of industry. We shall, therefore proceed to describe

THE INDIAN TOMBS.

Burials were performed by the Peruvians in two different ways, above and below ground. The still existing elevated mounds remind us of the Egyptian catacombs, though those of the Peruvians are smaller, and constructed of stone and earth. These monuments of the Incas are of a pyramidal form and different dimensions, some being more than one hundred and fifty feet high, and are known by the name "Cucara." They are built in subdivisions formed of large slabs of slate. In one of these divisions the body was placed, and in another the utensils and ornaments. Sometimes gold in its natural state was left in an earthenware vessel, mixed with pounded charcoal. When the chief or governor was interred, an imitation of the sun or the moon was placed in the tomb. The sun was represented by a flat, round plate of gold, or alloy of copper, about an eighth of an inch thick, and sometimes more than twenty inches in diameter. The moon was made of a silver plate, showing the half moon. A neck ring and bracelets, a waist band and ankle rings, made of gold, sometimes alloyed with copper, were also left with the body of a chief These rings are from one and a quarter to two inches in width, and opened and closed as a spring, They are thin and perfectly equal in width and thickness throughout. In fact, they are so perfect that it is difficult to imagine how such laminated rings were produced, considering the deficiency of suitable implements for such delicate and exact work. There are several of these tombs above ground still to be seen.

The excavated tombs,as found in our times, are all alike throughout South America. The Spanish conquerors having entered the territory of "la Capitana de la Neuva Granada," and collected all the gold they could among the Indians, turned their attention to the natural sources of gold, and also to the burial places, which soon became objects of much interest to the gold seekers. These tombs are always found on some isolated range with sharp outlines, so situated as not to admit of any water accumulating, and no apparent probability of water being led to it. In hills so situated the excavations are discovered by observing certain concavities on the surface; but where a thick forest exists, with a dense undergrowth, often of several feet, it is necessary to clear the ground by fire. It is generally allowed that a long period has elapsed since these tombs were closed, as by the accounts of the Mexicans and Peruvians, given at the time of the conquest, their calculations amounted to about two thousand years. The excavation is circular and perpendicular, and three or four feet in diameter, dug out of the decomposed syenitic rock. At the depth of nine to eleven feet charcoal is found among the soil, under which a flat stone (some kind of slate) covers the pit, on removing which the edge of a perpendicular slab is observed. At about four feet deeper the bottom of the tomb is reached, and on the perpendicular slab being removed, a horizontal excavation is seen towards the east. This is about four feet in height and the same in width but somewhat more in length. Here the bones of the defunct are found, the body having been placed in a sitting posture, with the face towards the east, that is towards the rising sun, regarded as the "King of the Heavens." The bones are generally found in such a decayed state that they will not admit of being handled. The earth, which has more or less fallen in and mingled with the remains, is gathered and brought under the washing process, and the trinkets thus obtained are partly of gold, with its natural alloy (silver), and partly gold with copper. On one side of the remains a large earthenware vessel is found, covered with a piece of slate, and in some instances a sediment has been found deposited from the drink, the Indian "chicha," left with the deceased. On the opposite side, perfectly decayed, ears of Indian corn have been found. In a niche c t out of the end of a tomb, a vase of earthenware is sometimes found, covered with a stone, and filled with pounded charcoal, in which the remaining trinkets and gold-dust, left with the occupant of the grave, had been deposited. Implements for smelting gold, and some tools made of gold and copper, are sometimes, though but rarely, found in the pot occupying the niche. The Spaniards, who during three centuries have gathered gold from the fluvial deposits, have found many of these burial places very remunerative.

Some localities show that systematically arranged cemeteries have formerly existed where two excavations in the centre, of greater depth than the surrounding ones, were found. The deep graves appear to have been appropriated to the chiefs and their families, and the numerous others to the inferior classes. These burying places are termed "Pueblo de Indios," but these larger cemeteries are now seldom found. Traditional accounts of certain localities are still preserved and eagerly sought after, where great treasures are said to have been buried. In like manner reports are often heard of rich fluvial deposits of a more recent date, where the proprietor is said to have had a measure corresponding to about twenty to twenty-five pounds weight, on collecting his weekly produce. This may be regarded as probable, if we consider that as many as from two to three hundred African slaves were often employed in mining pursuits by one proprietor.

The foregoing narrative supplies a proof that the aboriginal inhabitants of South America had some indefinite notion of a future state; they appear to have believed "that their deceased relative or friend had a long way before him," and that he would require some refreshment in his long journey to "reach the stars." This idea still extensively prevails."

MONTHLY METEOROLOGICAL REGISTER, ST. MARTINS, ISLE JESUS, CANADA EAST, (NINE MILES WEST OF MONTREAL,) FOR THE MONTH OF FEBRUARY, 1861.

Latitude, 45 degrees 32 minutes North. Longitude, 73 degrees 36 minutes West. Height above the level of the Sea, 118 feet.

BY CHARLES SMALLWOOD, M.D., LL.D.

Day of Month.	Barometer—corrected and reduced to 32° F. (English inches.)			Temperature of the Air.—F.			Tension of Aqueous Vapour.			Humidity of the Atmosphere.		
	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.
1	29.512	29.C?2	29.924	17.1	20.6	20.0	.078	.085	.091	.83	.78	.85
2	482	495	601	19.0	20.1	20.6	.087	.091	.085	.84	.85	.78
3	30.064	30.184	30.331	7.8	6.0	— 9.5	.010	.035	.022	.64	.61	.78
4	245	137	170	—11.3	0.0	1.1	.014	038	.038	.58	.85	.54
5	29.612	600	29.914	24.2	29.9	23.0	.123	.136	.106	.93	.84	.86
6	30.157	29.408	463	7.2	30.3	24.6	.042	.142	.094	.70	.84	.73
7	29.420	517	880	— 6.0	— 6.0	—21.8	.024	.022	.011	.70	.68	.64
8	30.214	30.307	30.388	—3..1	—14.1	—19.5	.001	.011	.012	.09	.74	.67
9	585	537	392	—24.0	0.0	— 7.0	.009	.027	.019	.60	.61	.60
10	162	114	094	7.0	27.2	31.9	.015	.105	.152	.76	.80	.89
11	170	29.956	29.770	27.2	44.3	40.1	.127	.240	.225	.86	.82	.91
12	29.631	371	448	39.4	43.7	36.2	.210	.248	.190	.86	.87	.88
13	571	810	30.061	32.9	30.8	21.6	.147	.142	.100	.81	.80	.79
14	30.088	30.201	174	8.4	33.8	22.4	.048	.144	.095	.97	.75	.80
15	29.914	29.720	29.499	19.6	22.5	19.9	.081	.084	.081	.77	.71	.77
16	504	614	654	9.0	29.4	20.4	.051	.136	.085	.37	.82	.78
17	125	101	350	27.6	31.8	31.1	.141	.149	.140	.91	.84	.80
18	502	552	746	21.7	31.2	23.7	.090	.136	.100	.78	.77	.79
19	849	850	7.7	9.4	34.1	11.8	.050	.155	.051	.70	.79	.76
20	584	300	267	14.1	29.8	24.1	.063	.148	.111	.80	.89	.86
21	342	541	841	26.0	27.4	11.1	.111	.123	.057	.81	.83	.79
22	977	965	999	— 1.0	11.0	2.0	.028	.048	.034	.68	.69	.71
23	30.030	544	495	3.0	8.4	6.0	.036	.042	.043	.72	.66	.75
24	29.371	711	30.090	16.1	16.1	6.7	.074	.074	.037	.83	.83	.62
25	30.104	30.060	29.954	2.0	32.0	25.2	.034	.149	.117	.71	.84	.87
26	29.827	29.757	30.061	27.4	35.4	32.5	.123	.177	.156	.84	.85	.85
27	30.189	30.063	039	17.2	55.2	40.2	.079	.328	.225	.82	.85	.89
28	010	000	29.910	30.2	53.1	38.0	.147	.348	.193	.89	.86	.86

Day of Month.	Direction of Wind.			Horizontal Movement in 24 hours. In miles.	OZONE. Mean amount of, in tenths.	RAIN. Amount of, in inches.	SNOW. Amount of, in inches.	WEATHER, CLOUDS, REMARKS, &c. &c. [A cloudy sky is represented by 10, a cloudless one by 0.]		
	6 a. m.	2 p. m.	10 p. m.					6 a. m.	2 p. m.	10 p. m.
1	N. E by E.	N. E. by E.	N. E. by E.	277.46	6.5	....	1.75	Snow.	Sleet.	Cu. Str. 10.
2	N. E. by E.	N. N. E.	S. W.	110.10	5.5	....	....	Cu. Str. 10.	"	" 10.
3	N. by W.	W. by N.	S. S. W.	269.40	4.0	....	....	" 6.	Clear.	Clear. Zod. light, bright.
4	E. by N.	N. E.	N. E.	28.50	4.5	....	0.70	Clear.	Cu. Str. 10.	Cu. Str. 9. Rain in night.
5	S. W.	S.	S. W.	13.74	4.5	Inapp.	....	Cu. Str. 10.	" 10.	Snow.
6	S. S. W.	W. S. W.	S. by W.	280.56	4.0	....	1.00	" 10.	" 10.	Cu. Str. 10.
7	N. E. by E.	N.	N. by W.	557.10	3.5	....	1.60	Snow.	Heavy drift.	Loud and Heavy drift.
8	W by S	W. S. W.	W. S. W.	444.80	3.0	....	....	Clear.	Clear.	Clear.
9	W. S. W.	N. E. by E.	N. E. by E.	98.40	3.0	....	....	"	C. C. Str. 4.	Cu. St. 10.
10	N. E. by E.	S.	E.	116.60	3.5	....	....	Sleet.	Sleet.	Slight Rain.
11	N. E. by E.	E. S. E.	E. S. E.	80.10	5.0	0.121	....	Slight Rain.	Cul. Str. 10.	Cu. Str. 10.
12	S. S. E.	S. S. W.	W. S. W.	74.50	5.0	0.640	....	Cu. St. 10.	" 10.	Clear. Aurora Borealis.
13	W. S W.	W. S. W.	W. S. W.	170.80	2.5	....	....	C. C. Str. 8.	" 10.	"
14	W.	W.	N. E. by E.	39.80	3.0	....	....	Clear.	Clear.	Cu. Str. 10.
15	N. E. by E.	N. E by E.	N. E. by E.	457.70	4.5	....	2.10	Nim. 10.	Snow.	Snow.
16	N. E. by E.	N. E. by E.	N. E. by E	250.80	4.5	....	1.46	Snow.	Cu. Str. 4.	Light Cirr. 2.
17	N. E. by E.	W. by N.	S. W.	196.50	6.0	....	7.26	"	Snow.	Cu. Str. 10.
18	W.	W.	N. by W.	247.70	4.0	....	....	Cu. Str. 10.	Cu. Str. 10.	C. C. Str. 8.
19	W. S. W.	S. S. W.	N. E. by E.	43.10	3.0	....	....	Clear.	C. C. Str. 4.	Cirr. 4.
20	N. E. by E.	N. E. by E.	W. S. W.	100.00	3.0	....	6.51	Snow.	Snow.	Cu. Str. 10.
21	W. S. W.	W. S. W.	W. by N.	245.40	3.0	....	....	C. C. Str. 10.	Cu. St. 6.	C. C. Str. 4.
22	W. by N.	W.	W.	258.89	2.0	....	....	Cum. 2.	Clear.	Cirr. 2. Lunar Halo.
23	N. E. by E.	N. E. by E.	N. E. by E.	228.20	5.0	....	5.47	Cu. Str. 10.	Snow.	Snow.
24	W.	W. by N.	W. by N.	418.00	3.5	....	....	Clear.	Cum. 4.	Cirr. Str. 2.
25	W. N. W.	S. W.	S. by E.	233.30	2.0	....	....	"	Clear.	C. C. Str. 10.
26	W. S. W.	W.	S. W.	177.90	3.0	....	....	"	Cu. Str. 10.	Cu. Str. 6.
27	S. S. E.	W. S. W.	W. S. W.	4.30	2.0	....	....	"	Clear.	Clear. Aurora Borealis.
28	S. W.	S. by W.	S. by W.	126.00	2.0	....	....	"	"	Cu. Str. 10.

REPORT FOR THE MONTH OF MARCH, 1861.

Day of Month.	Barometer—corrected and reduced to 32° F. (English inches.)			Temperature of the Air.—F.			Tension of Aqueous Vapour.			Humidity of the Atmosphere.		
	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.
1	29.891	29.904	29.905	34.4	48.4	35.0	.169	.260	.162	.84	.78	.80
2	862	894	732	31.4	43.4	36.1	.149	.193	.170	.84	.71	.80
3	474	247	475	31.5	41.4	39.0	.182	.228	.201	.94	.87	.88
4	30.454	30.371	549	31.4	34.6	29.0	.142	.169	.129	.84	.84	.82
5	29.674	29.716	824	9.0	30.4	15.2	.051	.136	.070	.77	.83	.82
6	816	450	716	16.7	21.6	12.8	.058	.074	.081	.75	.64	.71
7	30.190	30.188	30.398	—11.4	3.0	0.0	.020	.032	.030	.70	.60	.64
8	327	120	29.810	— 1.0	26.6	29.8	.030	.117	.136	.69	.82	.83
9	29.650	29.481	320	34.2	35.6	33.1	.182	.163	.168	.95	.83	.89
10	550	727	30.076	29.4	29.1	19.1	.136	.142	.077	.84	.86	.76
11	30.117	30.100	049	— 1.1	30.9	17.7	.028	.140	.072	.68	.85	.75
12	29.664	069	147	21.4	27.0	10.4	.085	.117	.050	.78	.82	.80
13	939	080	167	10.6	22.6	18.4	.054	.095	.077	.78	.79	.76
14	30.273	214	120	— 4.0	21.9	5.5	.024	.074	.032	.61	.64	.60
15	137	29.958	000	1.0	32.5	16.1	.040	.137	.070	.85	.74	.80
16	29.753	401	29.450	— 1.0	36.7	29.9	.031	.170	.130	.70	.80	.78
17	820	30 040	30.220	— 5.0	7.3	— 2.9	.022	.037	.032	.63	.62	.82
18	30.197	420	500	—16 4	12.9	— 4.2	.012	.045	.024	.69	.60	.65
19	543	330	198	—17.1	15.9	1.6	.003	.059	.026	.12	.66	.56
20	277	247	138	— 3.7	31.9	7.0	.031	.136	.037	.83	.78	.64
21	29.905	29.900	29.914	6.0	20.0	25.0	.040	.075	.101	.75	.71	.76
22	30.026	30.011	30.090	18.6	47.1	27.9	.077	.273	.123	.76	.85	.88
23	29.948	29.741	29.542	15.2	48.4	39.0	.061	.260	.201	.74	.78	.86
24	450	576	864	31.0	32.3	26.4	.058	.156	.1?7	.85	.85	.83
25	30.176	30.040	920	14.4	36.9	32.1	.161	.156	.162	.74	.75	.87
26	29.899	29.746	748	29.4	34.6	33.7	.148	.162	.162	.89	.83	.84
27	524	476	518	33.4	38.1	37.8	.168	.208	.193	.89	.91	.86
28	781	950	30.060	20.0	?4.2	29.0	.081	.155	.129	.77	.79	.82
29	30.214	814	29.770	21.1	29.0	33.1	.081	.158	.168	.77	.68	.89
30	29.198	607	30.134	49.5	38.7	29.3	.219	.180	.136	.87	.77	.83
31	428	441	593	15.0	32.4	20.4	.061	.137	.081	.78	.74	.77

Day of Month.	Direction of Wind.			Horizontal Movement in 24 hours. In miles.	OZONE. Mean amount of	RAIN. Amount of, in inches.	SNOW. Amount of, in inches.	WEATHER, CLOUDS, REMARKS, &c., &c. [A cloudy sky is represented by 10, a cloudless one by 0.]		
	6 a. m.	2 p. m.	10 p. m.					6 a. m.	2. p. m.	10 p. m.
1	N. N. E.	S. W.	S. W.	133.26	3.5	....	....	Cu. Str. 9.	C. C. Str. 6.	C. Str. 9. Aurora borealis.
2	S. by W.	S. by W.	N. E. by E.	10.69	4.5	Inapp.	....	" 10.	C. Str. 10.	Cu. Str. 10.
3	N. E. by E.	W.	W. S. W.	46.30	5.5	0.747	....	Rain.	" 10.	Clear.
4	W. S. W.	W. S. W.	W.	270.70	3.0	....	....	Clear.	Cu. Str. 2.	Scud. 4.
5	W.	W.	W. S. W.	274.00	3.0	....	....	Cu. Str. 10.	" 4.	Clear.
6	S. W.	W.	W.	299.10	4.5	....	0.96	Snow.	Snow.	Slight Snow.
7	W. by N.	W. S. W.	W. S. W.	370.90	2.5	....	....	Clear.	Clear.	Clear.
8	S. E. by E.	S. S. E.	S. S E.	180.90	3.5	....	....	"	C. C. Str. 8.	C. C. Str. 4.
9	S. S. E.	W.	W.	120.70	7.5	0.264	0.77	Rain.	Rain.	Cu. Str. 10.
10	W. S. W.	W. S. W.	W. S. W.	272.10	6.0	....	1.40	C. C. Str. 8.	Cu Ct Str. 3.	Clear.
11	W.	W.	S. S. E.	69.20	3.0	....	....	Clear.	Clear.	C. C. Str. 10.
12	S. S. E.	W.	S E. by E.	319.80	4.5	....	1.04	Str. 4.	"	Clear.
13	S. S. E.	W. by S.	W. S. W.	232.90	7.5	....	3.07	Snow.	Snow.	Cu Str. 8. Aurora borealis.
14	N. W. by N.	N. E. by E.	N. E. by E.	14.66	3.0	....	....	Clear.	Clear.	" 2, " "
15	N. E. by E.	S. by W.	S. S. W.	17.10	2.5	....	....	"	"	Str. 2, " "
16	N. W.	S. by N.	S. S E.	27.80	2.0	Inapp.	....	"	Cirr. 6.	Slight Rain.
17	W.	W.	N. N. W.	343.50	2.0	....	....	"	Clear.	Clear.
18	W.	S. W.	S. S. W.	56.90	2.0	....	....	"	"	"
19	N. E. by E.	N E. by E.	N. by E.	103.69	2.0	....	....	"	"	"
20	N. E. by E.	N. E. by E.	N. E. by E.	10.90	1.0	....	....	"	"	Cirr. 4. Lunar Halo.
21	N. E. by E.	N. E. by E.	N. E. by E.	27.60	4.0	....	1.10	C. Str. 10.	Snow.	C. C. Str. 6.
22	N. E. by E.	S. W. by W.	W. S. W.	35.20	3.0	....	....	Cu. Str. 6.	Clear.	Clear.
23	E. S. E.	E. by N.	S.	70.80	2.5	....	....	Clear.	Cir Cum. 4.	Cu. Str. 10.
24	S.	W. S. W.	N. W.	372.60	2.0	....	....	C. C. Str. 4.	Cu. Str. 10.	Clear.
25	W. S. W.	S. E. by E.	E. S. E.	111.20	2.0	....	....	Clear.	C. C. Str. 4.	C. C. Str. 10.
26	N. E. by E.	N. E. by E.	N. E. by E.	152.80	6.5	0.510	....	Cu. Str. 10.	Rain.	Rain.
27	N. E. by E.	N E. by E.	S. S. W.	209.56	4.0	0.235	....	" 10.	Fog.	Cu. Str. 10.
28	W.	W.	W S. W.	618.79	3.0	....	....	" 4.	Clear.	Clear. Aurora borealis.
29	N. E. by E.	N. E. by E.	N. E. by E.	335.20	5.0	....	....	Cirr. 4.	Cu Cirr. 4.	Sleet.
30	W. S. W.	W.	N. W.	187.50	3.5	....	....	Rain.	C. C. Str. 6.	Cirr. 4. Aurora borealis.
31	N. E. by E.	E. S. E.	S. by W.	72.20	2.0	....	....	Clear.	" 6.	Clear.

REMARKS FOR FEBRUARY, 1860.

Barometer....... Highest. the 9th day, 30·585 inches. Lowest, the 17th day, 29.101 " Monthly Mean, 29.750 " " Range, 1·484 "

Thermometer... Highest, the 29th day, 55°2. Lowest, the 8th day, —37°1. Monthly Mean, 18°25. Monthly Range, 90°3.

Greatest intensity of the Sun's rays, 80°1.

Lowest point of Terrestrial radiation,—39°4.

Mean of Humidity, .755.

Rain fell in 3 days, amounting to 0.761 of an inch; it was raining 17 hours and 25 minutes.

Snow fell on 9 days, amounting to 27·85 inches; it was snowing 73 hours and 45 minutes.

Most prevalent wind, the N. E. by E.

Least prevalent wind, the E.

Most windy day the 7th day, mean miles per hour, 23.12.

Least windy day the 7th day, mean miles per hour, 0.17.

Aurora Borealis visible on 2 nights.

Lunar Halo visible on 1 night.

Zodiacal Light bright.

Crows 1st seen on the 27th day.

The Electrical state of the Atmosphere has indicated constant and moderate intensity.

REMARKS FOR MARCH, 1861.

Barometer. ...... Highest, the 31st day, 30.529 inches. Lowest, the 30th day, 29.198 " Monthly Mean, 29.878 " Monthly Range, 1·401 "

Thermometer. Highest, the 1st day, 48°4. Lowest, the 19th day,—17°1. Monthly Mean, 21°94. Monthly Range, 65°5.

Greatest intensity of the Sun's rays, 76°6.

Lowest point of terrestrial radiation,—19°7.

Mean of humidity, .768.

Rain fell on 6 days, amounting to 1.756 of an inch; it was raining 52 hours 35 minutes.

Snow fell on 6 days, amounting to 8.34 inches, it was snowing 40 hours and 15 minutes.

Most prevalent wind, the N. E. by E.

Least prevalent wind, the E. by N.

Most windy day, the 28th day; mean miles per hour, 25.77.

Least windy day, the 2nd day; mean miles per hour, 0.61.

Aurora Borealis visible on 6 nights.

Lunar Halo visible on 1 night.

Imperfect Solar Halo the 31st day.

Zodiacal light was bright.

The Electrical state of the Atmosphere has indicated moderate intensity.

CONTENTS OF NUMBER II.

☞ All business communications to be addressed, *prepaid*, to the Publishers. Articles and communications for publication in the Journal may be addressed to the Editors, care of the Publishers.

☞ Authors of original articles can have 12 copies of them by giving timely notice; it is too late when the forms are broken up.

☞ The next number of this Journal will be published in June 1861.