Technical and Bibliographic Notes / Notes techniques et bibliographiques

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

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

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

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

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

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

☐ Additional comments:/ Commentaires supplémentaires:

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

10X	14X	18X	22X	26X	30X
			✓		

12X 16X 20X 24X 28X 32X

THE

CANADIAN NATURALIST.

SECOND SERIES.

MICHAUX AND HIS JOURNEY IN CANADA.

By the Abbé Ovide Brunet, Professor of Botany at the Laval University, Quebec.*

It is well known to botanists, that the *Flora Boreali-Americana* of Michaux often fails to indicate the precise localities of the plants there first described, and that, in consequence, many of these plants are either still unknown to collectors, or excessively rare. In the hope of being able to determine the localities of those plants which this author has noticed as occurring in Canada, I attempted several years since to trace the steps in his journey to the Saguenay, and to Hudson's Bay. At that time however, the only materials at my disposal were the *Flora*, and some scattered notes in the works of his son. I had not then seen his Herbarium, which is rich in notes of localities; and the manuscript journal of his journey, in the library of the American Philosophical Society in Philadelphia, was unknown to me. Since that time however, I have been able to consult the original collections of Michaux, which are in part at the Jardin des Plantes of Paris, and in part in the museum of Mr. Benjamin Delessert of that city. The American Philosophical Society has moreover permitted me to copy the manuscript journal, for which favor I take this occasion of expressing my thanks.

* Translator's Note.—This interesting paper was printed a few months since, in French, by Mr. Brunet, for private distribution only. I have accordingly translated it for publication in the *Canadian Naturalist*, suppressing some unessential portions, with the approbation of the author; who has added to it a map of the region from Lake St. John to Hudson's Bay. A MS. map by the Jesuit Laure, who was a missionary in Canada during the early part of the last century, is the chief authority for the region beyond Lake St. John, though other old French maps were consulted. The map of Laure is in the library of the Canadian Parliament.—T. S. H.

In the following pages, which I have prepared with the aid of the materials thus placed at my disposal, I shall give a list of the most interesting plants found by our botanist in the various localities visited during his Canadian journey; while for the more common species, I shall only notice the most northern points at which they were observed. There will be found in these pages, notices of more than one hundred and sixty plants observed by Michaux in localities not mentioned in his Flora. These indications, it is to be hoped, will not be devoid of interest to collectors, and to students of geographical botany; while in addition will be found some interesting details from the journal of Michaux on the characters of a portion of that almost unknown region which forms the water-shed between the St. Lawrence and Hudson's Bay.

André Michaux, the early years of whose life were devoted to agriculture, soon conceived a plan for visiting foreign countries with the object of studying their plants, and, if possible, introducing them into France. As a preparation for this, he came to Paris in 1779, and studied botany for two years under Bernard de Jussieu. After having in the pursuance of his plan visited England, and crossed the Pyrenees into Spain, he visited Persia, from whence he brought great collections of plants and seeds. The French government, desirous of introducing into France some of the trees of North America, then decided on sending Michaux to this continent; where his orders were to travel through the United States, and collect both trees and seeds, which were to be sent to France. In pursuance of this mission, he sailed on the 25th of August 1785, and reached New York the 1st of October, accompanied by a gardener. Although his journey had for its chief object the introduction of forest-trees, Michaux had received orders to send also such shrubs and plants as might serve to ornament the king's gardens.

He at first made New York his head-quarters, from which he visited New Jersey, Pennsylvania, and Maryland, and he established a nursery in New Jersey, with a view of raising young trees which should be of better growth than those found in the forests. In the year following, Michaux sent to Paris twelve boxes of seeds, and several thousand young trees. After a time he removed to Charleston, South Carolina, and there established a second nursery, which soon obtained great dimensions from the immense collections of trees and shrubs, the fruit of more than sixty journeys in various parts of the interior. The manuscript

notes of Michaux, however, give us no details of these excursions up to the month of April 1787, when he made his first journey to the Alleghanies, going up the Savannah River to its head, and thence gaining the heights of the mountain region. Having made friends with some of the Indians, he then ascended with them one of the tributaries of the Savannah, and reached a branch of the Tennessee on the other side of the mountains. This was the limit of his voyage, and he then returned to Charleston on the first of July, after a voyage of 300 leagues in South Carolina and Georgia. His manuscript notes of this journey contain many observations on the plants met with, and precise indications of their localities. In 1788 and 1789 he visited, successively, Florida, the Lucayan islands, and Virginia, passing through the mountain region of North Carolina. He returned to Charleston from this last excursion in September 1789, but revisited the region in the course of the following winter, accompanied by his son, reaching Charleston again in the spring of 1790, where he remained until April 1791. His notes during this year are wanting.

Michaux had now spent six years in America, his pecuniary resources were nearly exhausted, and he feared to be obliged to return to France without having completed his plans on this continent. He had long desired to add to his studies upon the American Flora, some researches on the geographical distribution of the forest trees, and to determine the native region of each, which he regarded as that in which the plant attains its greatest size and strength. The tulip-tree (*Liriodendron tulipifera*), for example, appears in Western Canada with a maximum height of sixty feet, and a diameter of three feet; while westward, and especially in Kentucky, where it forms by itself vast forests, it reaches a height of one hundred and forty feet, and a diameter of seven or eight feet. To the northward, on the contrary, it becomes rarer and smaller, and Michaux was hence led to regard this tree as a native of Kentucky. In accordance with these views, he resolved to study the topography of the North American trees. He had already extended his travels southward to Florida, but another journey, longer and more difficult, but still more important to his investigations, yet remained to be accomplished,—a visit to Canada and northward as far as Hudson's Bay. This project he attempted in 1792. Leaving Charleston in April, he proceeded northward by land, and, as we learn from his manuscript notes,

went first directly to New York, thence to New Haven, and finally to Albany, where he arrived on the 14th June. On the 18th we find him at Saratoga, and on the 20th he embarked on Lake Champlain at Whitehall. The remainder of this month was employed in examining the vegetation on the shores of the lake, which he crossed several times. In his Flora, mention is made of a great number of plants which he found in this region.* On the 30th of June, Michaux reached Montreal, where he spent ten days in collecting the plants of the environs. On the 1st of July, he tells us he botanized on the mountain. "On the 3rd, in the country and the low meadows," and "on Sunday the 8th, in the wood of Lachine, for a league along the river-side." In these excursions he collected the following plants, which are marked in his herbarium as having been collected about Montreal:

Scirpus spathaceus, Michx.; *Elodea Canadensis*, Michx.; *Poa compressa*, Linn.; *Scutellaria parvula*, Michx.; *Oxalis corniculata*, Linn.; *Hypericum macrocarpum*, Michx.; *Acalypha Virginica*, Linn.; *Zanthoxylum fraxineum*, Willd.

On the 11th June Michaux left for Quebec; but adverse winds obliged him to put in at Sorel and at Batiscan, where he made collections. In the latter locality he found *Scheuchzeria palustris*, Linn.; *Triglochin maritimum*, Linn.; *Drosera longifolia*, Linn.

He reached Quebec on the 16th July, and remained there a fortnight, in which time he made several excursions in the environs, visiting the Falls of Montmorency, Lorette (probably La Jeune Lorette), and botanized in the forest on the right bank of the river St. Charles. As the season was advancing, he now made arrangements for his journey to Hudson's Bay. Engaging as an interpreter a young half-breed, who had been three years with the Indians, he started for the Saguenay. The following extracts from his notes will show his route:

---

* It would be superfluous to furnish lists of plants whose names and localities are found in the *Flora* of Michaux. When therefore in this narrative I give a list of plants found by our botanist in any locality, it will be understood to include only those which have not been mentioned in his *Flora* as there occurring; but which are given in his Herbarium, or in his manuscript notes as having been found in that locality. For the convenience of reference, however, I give in the following manner, the pages where the plants not here named will be found mentioned:

Flora Boreali-Americana, in Canada, ad ripas lacus *Champlain*, vol. i, fol. 47, 75, 136, 153, 304; vol. ii, fol. 28, 198, 227, 245.

"Left Quebec July 31, sailing by Cape Tourmente and Cape Brulé, which are distant twelve and fourteen leagues from Quebec. Saw upon the mountains *Juniperus communis*, *Thuja*, *Abies balsamea*, *A. alba*, *Epigæa repens*, *Linnæa borealis*, etc., etc. .....That night lay off Bay St. Paul.....August 1st. The wind changed and rain fell; botanized on the mountains..... August 2nd. Arrived at Malbaie, and left there on the 4th, reaching the mouth of the Saguenay, where I passed the night. On the morning of Sunday the 5th reached Tadoussac, forty-six leagues from Quebec."

The plants collected by Michaux at Malbaie were as follows:

Hippuris vulgaris, Linn.; *Salicornia herbacea*, Linn.; *Pulmonaria parviflora*, Michx.; *Ligusticum Scoticum*, Linn.; *Salsola salsa?* Michx.; *Polygonum cilinode*, Michx.; *Potentilla hirsuta*, Michx.; *Astragalus secundus*, Michx.;* *Medicago lupulina*, Linn.; *Pteris gracilis*, Michx.

A little lower down on the shores of the St. Lawerence he gathered *Salicornia herbacea*, Linn.; *Arundo arenaria*, Linn.; *Glaux maritima*, Linn.; *Salsola salsa?* Michx.; *Atriplex patula*, Linn.; *Rumex verticillatus*, Linn.; *Arenaria rubra*, Linn., (= *Spergularia rubra*, Pers.); *Potentilla hirsuta*, Michx.; *Empetrum nigrum*, Linn.

The picturesque little village of Tadoussac is built upon a point of rock at the entrance to the Saguenay, and was a post of the Hudson's Bay Company. Here Michaux bought two bark-canoes, and engaged three Indians; here also, as we learn from his Flora and his Herbarium, he collected the following plants: *Ligusticum Scoticum*, Linn.; *L. actæifolium*, Michx.; *Gentiana acuta*, Michx.; *Epilobium tetragonum*, Linn.; *Vaccinium Vitis-Idæa*, Linn.; *Potentilla hirsuta*, Michx.; *Ilex Canadensis*, Michx. †

He was soon however on his way up the Saguenay, which for a distance of twenty-seven miles flows between immense walls of gneiss, often extremely bold and picturesque. The banks are almost destitute of vegetation, except in the fissures of the rocks, where a few stunted pines and spruces, wild gooseberries and blueberries laden with fruit, and a juniper (*Juniperus sabina*), form

* See note† on page 331.

† Flora Boreali-Americana, ad ripas fluminis *S. Laurentii*, juxta Tadoussac, vol. i, fol. 166, 177; in fluminis *S. Laurentii* aquis affluente mare subsalsis, vol. i, fol. 1, 67, 95, 102, 132.

a green tapestry hanging on the embankments, which rise sometimes a height of 1100 feet.*

As we approach Ha! ha! Bay the shores become lower, and the great pine forests which form the wealth of this region are seen. At Chicoutimi, where the river ceases to be navigable for large vessels, it spreads into a wide basin which receives a cascade of forty feet in height. Michaux reached this spot on the 11th of August.

Chicoutimi, which signifies *deep water*, was then a little village at the junction of the river of this name with the Saguenay. Upon a point which projects into the basin was a small chapel about twenty-five feet long, built by the Jesuits, and having within a single altar and a few pictures, while outside was seen the tomb of Père Coquart, the last of the Jesuits, who, with the Père Labrosse, had first preached the Gospel to the natives. Michaux, in the manuscript notes which he left to his son, thus speaks of this chapel: "On my way to Hudson's Bay I reached in the month of August the Lake Chicoutimi, near the 48th degree of latitude, and there found the church erected in 1728 (as indicated by the date placed over the principal entrance) by the Jesuit fathers for the natives of the vicinity. This building, made of squared timbers of white cedar (*Thuja occidentalis*) placed upon each other, was in good preservation; and although these beams had never been covered either within or without, the wood at the depth of half a line was not the least altered after a lapse of more than sixty years."† This little chapel was still standing in 1857.

The route to Lake St. John was then much more difficult than that which is now followed. Michaux went up the river Chicoutimi in a canoe and then passed through Lake Kinogomi, from which, by a portage of half a mile, he reached Lake Kinogomichiche; this discharges itself by a slow and tortuous stream into Belle River, which falls into Lake St. John, which our traveller reached after a journey of six days from Chicoutimi, gathering the following plants in his way:

Scirpus spathaceus, Michx.; *Swertia corniculata*, Linn.; *Prinos verticillatus*, Linn.; *Gentiana pneumonanthe*, Linn.; *Drosera rotundifolia*, Linn.; *Triglochin palustre*, Linn.; *Juncus fluitans*, Michx.; *Mitella diphylla*, Linn.; *Sparganium natans*, Michx.;

* Flora Boreali-Americana, in saxosis ad amnem *Saguenay*, vol. i, fol. 3. vol. ii. fol. 246.

† Michaux fils, Arbres Forestiers, vol. iii, p. 34.

Nymphœa lutea, β. Kalmiana, Linn.; *Spergulastrum lanceolatum*, Michx., (=*Stellaria borealis*, Bigelow); *Alnus crispa*, Michx.; *A. glauca*, Michx.; *Lobelia Dortmanna*, Linn.

Lake St. John lies between latitude 48° 23′ and 48° 42′, and between longitude 71° 29′ and 72° 9′, its greatest length being sixteen leagues; it is more than thirty leagues to the north of Quebec. Michaux went entirely around it, and collected a great number of plants;* but in pursuance of his plan of studying the trees, he also penetrated into the surrounding forests, which abound in valuable timber-trees, details with regard to the nature and distribution of which, will be given further on.

It was on the 16th August that our botanist reached this lake, but, delayed by an adverse wind, he spent the next day at the mouth of Belle River, where he found *Lycopus Virginicus*, Linn.; *Circœa Canadensis*, Linn.; *Bromus Canadensis*, Michx.; *Arundo arenaria*, Linn.; *Galium Claytonii*, Michx.; *G. asprellum*, Michx.; *Cornus alternifolia*, Linn.; *Polygonum amphibium*, Linn.; *Cerasus pumila*, Michx.; *Lathyrus palustris*, Linn.; *Astragalus secundus*,† Michx.; *Hedysarum alpinum*, Michx.; *Aster amygdalinus*, Michx.; *A. cordifolius*, Linn.; *Solidago flexicaulis*, Linn.; *S. aspera*, Ait.; *Senecio pauperculus*, Michx.; *Artemisia Canadensis*, Michx.; *Lobelia Kalmii*, Linn.; *Eriocaulon pellucidum*, Michx.; *Calla palustris*, Linn.; *Salix cordata*, Michx.; *Ilex Canadensis*, Michx.; *Vitis riparia*, Michx.

Of the *Vitis* just named, Michaux has in his Herbarium the following notes: "Called beach-vine (*vigne des battures*) by the French voyageurs on the Ohio and Mississippi, because it grows upon the rocks and sands which are exposed to the annual floods. .....This species is never found to the east of the Alleghany Mountains."

---

* Flora Boreali-Americana, in lacu vel juxta lacum *S. Joannis*, vol. i, fol. 240, vol. ii, fol. 205, 220, 225.

† Prof. Asa Gray had for some time supposed the *Astragalus secundus* of Michaux to be the *Phaca astragalina*, D. C., (*Astragalus alpinus*, Linn.,) when in 1861, I re-discovered the plant at Lake St. John, where Michaux had first found it, and sent specimens of it to Prof. Gray, which fully confirmed his opinion that it is but another form of *A. alpinus*, Linn. But whence this difference of form? Last year, at the Island of Orleans, where this species is abundant, I found the two varieties in the same locality; and I was able to observe that when it grows on exposed rocks the plant has the ordinary form of *Phaca astragalina*; while on the contrary, when sheltered by a growth of taller plants, it assumes the slender and elongated form of the plant of Michaux.

Among the rivers which fall into Lake St. John is the Mistassini, called also R. des Sables, from the great quantity of sand which it brings down. By this river, which has a length of about 150 miles, the Indians known by the name of Mistassins, and living around the great lake of that name, were accustomed to descend at Pointe Bleue, the most northern trading-post in this region, where they sold their furs. They still come down every year in the month of June for the purpose of trade, and also to meet the missionary who pays them an annual visit. It was by this river that Michaux proposed to pass to Hudson's Bay. Leaving the post at Pointe Bleue on the 21st August, he reached in a few hours the river Mistassini. The waters were shallow, and for five or six leagues flowed through banks of moving sands, which were sometimes more than half a league long. The lands on either side were low and fertile, no mountains were visible, and the trees were chiefly elms, ashes, and pines, of a good growth.* At the end of about eighteen leagues Michaux arrived at a beautiful waterfall about eighty feet in height, and on the evening of the 22nd August encamped on the borders of the basin below.

This point which was known as Larges Rapides, Michaux observed as the northern limit of *Potentilla tridentata*, while *Gaultheria procumbens*† disappeared ten leagues above Lake St. John, although Hooker, in his *Flora Boreali-Americana*, has indicated Quebec as its northern limit.

The 23rd being a day of rain, Michaux remained in camp; but the three following days he continued the ascent of the river, which became narrower, and so rapid that the canoes could only be propelled by means of poles. At length he reached the portage called *Monte-à-peine*, where he was obliged to make a difficult and even dangerous ascent of a hill eight or nine hundred feet in height. From the summit he looked down into an immense valley, traversed by green hills which resembled great waves in an ocean of verdure. A single small river alone broke the monotony of this landscape; to it the travellers directed their steps, and soon reached a stream which was only about eighteen feet wide. During

* Flora, in Canada ad amnem *Mistassini*, vol. i, fol. 34, 61, 110.

† Some botanists have ventured to change the name of this plant to *Gautiera;* but the true orthography of the name of its discoverer is Gauthier, as appears from the registers of Notre Dame de Quebec (Register of Aug. 26, 1751). It would besides be undesirable to change a name consecrated like this by long use.

the portage the following plants were met with: *Vaccinium cæspitosum*, Michx.; *Epigæa repens*, Linn.; *Arbutus Uva ursi*, Linn.; *Lycopodium inundatum*, Linn.; *L. Selaginoides*, Linn.; *Botrypus lunaroides*, Michx.

The little river on which they now embarked was generally deep enough for their canoes, but the navigation was often interrupted by the dams constructed by the beavers, whose cabins were seen on the shores. This stream led them to Swan Lake (Lac des Cygnes), which they reached in the afternoon of the 29th August. This picturesque little lake, which is about forty-five leagues from Lake St. John, is very irregular in form, in some parts having a breadth of two leagues, and at others being very narrow. The shores are generally low, with occasional hills covered by stunted trees. Around the shores of this lake Michaux found the following plants: *Avena striata*, Michx.; *Arundo Canadensis*, Michx.; *Xylosteum villosum*, Michx.; *Juncus melanocarpus*, Michx.; *Vaccinium Vitis-Idæa*, Linn.; *Epigæa repens*, Linn.; *Epilobium oligænthum*, Michx.; *Potentilla fruticosa*, Linn.; *Aster uniflorus*, Michx.; *Carex lenticularis*, Michx.; *Abies balsamifera*, Michx.; *A. denticulata*, Michx.; *Betula glandulosa*, Michx.

He remarks that *Avena striata* is the only gramineous plant observed by him in this vicinity, and also that Swan Lake appears to be the most northern limit of *Vaccinium Vitis-Idæa*.

Lake Mistassini is about 100 leagues from Lake St. John, and Michaux had already traversed about half the distance, but the most difficult part remained. He had to cross a dismal wilderness, where the vegetation consists only of a small number of stunted and depauperated species. "The trees which predominate in the forests, a few degrees to the southward, have here almost entirely disappeared, from the severity of the winters and the sterility of the soil. All this region is traversed by thousands of lakes, and covered with enormous rocks piled upon one another, and generally covered with huge black lichens, which add to the gloomy aspect of this desert and almost uninhabitable country. Between these rocks are seen here and there some specimens of a stunted pine (*Pinus rupestris*), which at the height of three feet is seen bearing fruit, and having all the marks of decrepid old age. One hundred and fifty miles to the southward this pine attains a height of eight or ten feet, and presents a much more vigorous growth."*

* Michaux fils, Arbres Forestiers, vol. i, page 49.

Of this region, between Swan Lake and Lake Mistassini, Michaux remarks in his journal, that it evidently occupies the height of land, since the waters of the latter lake fall northward into Hudson's Bay, while those of Swan Lake through the river Mistassini reach Lake St. John and the St. Lawrence. We cannot give a better notion of the climate and vegetation of this elevated and semi-arctic region, than by the following extracts from the manuscript journal of Michaux:

"August 30th. We have passed through three lakes, which lie among low hills, and are connected by short streams. The whole of this region is cut up into mountains and hills; the low places between which are filled with water, forming innumerable lakes, which for the most part have no names among the Indians who hunt in this country. Wide intervals are often covered with *Sphagnum*, in which the traveller sinks to his knees, and which even in the dry weather is always saturated with water. In the course of the day we have made three portages, and have travelled three or four leagues only, on account of the difficulty of crossing these marshes.

"These marshes abound in *Kalmia glauca*, *Andromeda polyfolia*, *Sarracenia purpurea*, and *Vaccinium Oxycoccus*. In the drier parts are *Andromeda calyculata*, *Ledum palustre*, *Kalmia angustifolia*, *Epigæa repens*, and *Pinus rubra*. *Abies balsamifera* may be said to cease at Swan Lake: I saw only three specimens of it to day in the form of little shrubs. All the plants here seem like decrepid pigmies on account of the sterility and the severity of the cold.

"August 31st. We paddled for an hour; and then came to a portage. The cold was excessive, the sky cloudy for the last two days, and the rain like melted snow. When we stopped for breakfast, the cold took away our appetites, and the Indians, who were drenched with water, trembled with cold.

"September 1st. The rain prevented our travelling, and one of our Indians was sick. In the afternoon the weather was clearer, and we went on notwithstanding the rain. All night we had rain with thunder and lightning. We made six leagues, passing through a lake and along streams scarcely wider than a canoe.

"September 2nd. Sunday. The weather was very thick in the morning, and a half-melted snow fell; the cold became less severe, but we had a portage of three quarters of a league across a marsh. Despite showers of hail, which lasted all day, we kept on, for the

Indians, like myself, were most anxious to reach Lake Mistassini before the snow and cold should augment. We crossed three lakes, and travelled about ten leagues.

"September 3rd. Ice formed about a line in thickness. After midnight a white frost was seen on the vegetation around our camp, and there was promise of a fine day; but about seven in the morning the air became thick, and we had alternations of snow, rain, hail, and sunshine. * * * At eleven o'clock we reached a great river flowing northward, and with a favoring current we made eighteen or twenty leagues to-day. The soil appeared to grow better.

"September 4th. We were obliged to make three portages, on account of rocky rapids, and at a quarter past ten reached Lake Mistassini."

The following plants, in addition to these already mentioned, were met with in crossing the height of land: *Scirpus eriophorum*, Michx.; *Cinna arundinacea*, Linn.; *Arena striata*, Michx.; *Symphoricarpos racemosus*, Michx.; *Gentiana pneumonanthe*, Linn.; *Juncus melanocarpus*, Michx.; *Triglochin maritimum*, Linn.; *Alisma plantago*, Linn.; *Vaccinium oxycoccus*, Michx.; *V. cæspitosum*, Michx.; *V. myrtilloides*, Michx. (*V. Pennsylvanicum*, Lam.); *Mentha borealis*, Michx.; *Pinus inops?* Ait.; *Lycopodium Selaginoides*, Linn.

Of the great Mistassin Lake but little is known; the sketch of it given in the accompanying map represents its size and shape as far as can be gathered from the missionaries and Indian traders. Rupert's River, by which it empties into James's Bay, is described as being from fifty to sixty leagues in length, and larger than the Saguenay. Its name, and that of the natives of its shores, is derived from the Indian word *mistassini*, by which they designate a huge rock which hangs over the lake near its outlet, and is regarded as the abode of a Manitou or Great Spirit, who is an object of religious worship. When crossing the lake they are said to keep their eyes turned away from this rock lest he in his ire should excite a tempest. Near the lake, on a small river which flows into it, is said to be a rude cavern in marble, which the Indians call the house of the Great Spirit. The notes of Michaux add but little to our knowledge of this lake. He tells us, however, that the shores are low, and the hills remote, and adds that "the waters of the lake are discharged by rivers to the north and northwest, which fall into Hudson's Bay, the journey to which, from the

lake requires, according to the Indians, four days, although, on account of the rapids, it requires ten days to return."

Michaux reached Lake Mistassini on the 4th of September, and, after paddling along it for ten or twelve leagues, encamped on a long peninsula on the west side of the lake. The next morning he began to collect plants, of which he gives the following names, exclusive of those mentioned in his *Flora* as occurring in this region:*

Lycopus Virginicus, Linn.; *Scirpus sylvaticus*, Linn.; *S. eriophorum*, Michx.; *Phalaris arundinacea*, Linn.; *Cornus Canadensis*, Linn.; *C. stolonifera*, Michx.; *Potamogeton perfoliatum*, Linn.; *Linnæa borealis*, Gronov.; *Ulmus fulva*, Michx.; *Streptopus distortus*, Michx; *Convallaria stellata*, Linn.; *Triglochin maritimum*, Linn.; *Epilobium angustifolium*, Linn.; *Vaccinium oxycoccus*, Linn.; *V. hispidulum*, Linn.; *V. uliginosum*, Linn.; *Pyrola secunda*, Linn.; *Epigæa repens*, Linn.; *Spergularastrum lanceolatum*, Michx.; *Cerasus borealis*, Michx.; *Sorbus aucuparia*, Linn., (*Pyrus Americana*, D. C.); *Geum rivale*, Linn.; *Potentilla fruticosa*, Linn.; *Rubus occidentalis*, Linn.; *R. arcticus*, Linn.; *Prunella vulgaris*, Linn.; *Rhinanthus Crista-galli*, Linn.; *Sisyrinchium Bermudiana*, Linn.; *Geranium Carolinianum*, Linn.; *Bartsia pallida*, Linn.; *Hedysarum alpinum*, Michx.; *Hieracium scabrum*, Michx.; *H. Canadense*, Michx.; *Aster macrophyllus*, Linn.; *Solidago aspera*, Ait.; *Senecio, aureus*, Linn.; *Lobelia Dortmanna*,† Linn.; *Carex flava*, Linn.; *Betula papyrifera*, Michx.; *Sparganium angustifolium*, Michx.; *Abies alba*, Michx.; *A. balsamifera*, Michx.; *A. denticulata*, Michx.; *Pinus inops*?‡ Ait.; *Salix incana*, Michx; *Acer montanum*, Ait.; *Osmunda regalis*, Linn.

Having made his collections, and reached the other side of the lake, Michaux proceeded on his journey; chosing for this purpose, among the discharges of the lake, a large and fine river falling into Hudson's Bay, and known as the Rivière des Goëlands (Gull

* Flora Boreali-Americana, ad sinum *Hudsonis* et juxta lacus, *Mistassini*, vol. i, fol. 5, 11, 14, 61, 64, 111, 124, 191, 223; vol. ii, fol. 2, 115, 121, 123, 153, 154, 171, 172, 173, 175, 180, 283.

† The *Lobelia Dortmanna* is a rare species in Canada: I have as yet found it in but two localities, Lake Kenogami and Lake St. Joachim.

‡ The *Pinus inops* here mentioned is the *P. Banksiana*, Lamb., *P. rupestris*, Michx. fils., already mentioned on page 333. It may be here remarked, however, that it attains in some localities a height of thirty feet.

River), which is very probably that designated in the maps as Rupert's River. He followed this for some distance, and camped on the night of September 5th, near the Atchoukue or Seal River. The next day a cold fog was succeeded by rain and snow, and compelled him to stop. The Indians, fearing the rigors of the season, refused to go further, assuring him that if the snow continued it would be impossible for them to return. It was therefore decided that they should immediately retrace their way to Lake Mistassini, where they arrived that night. Along the banks of the Gull River the following plants were collected:—*Xylosteum villosum*, Michx.; *Primula Mistassinica*, Michx.; *Ledum latifolium*, Ait.; *Rubus Chamæmorus*, Linn.; *Aster umbellatus*, Michx.; *Carex Richardi*, Thuill.; *Betula nana*, Linn.; *Myriophyllum spicatum*, Linn.; *Salix incana*, Michx.; *Myrica Gale*, Linn.; *Lycopodium annotinum*, Linn.

Michaux left Lake Mistassini on the 7th of September. His journey back, although difficult, was rapid; and from the height of land the descending currents of the rivers, now swollen, enabled the travellers to pass down in their canoes over most of the rapids where they had made portages in ascending. On the 9th of September he passed Swan Lake and camped at Monte-à-Peine, and on the 10th reached the river Mistassini, and camped at night "four leagues below the Larges Rapides, near the first Weymouth pines (*Pinus strobus*) which we met on our way downwards." On the 12th, Michaux reached Lake St. John, and two days later left for Quebec; from which he returned, by way of Montreal and Lake Champlain, to Philadelphia, where he arrived on the 8th of December, 1792.

"REMINISCENCES OF AMHERST COLLEGE."

By Edward Hitchcock, D.D., LL.D.*

This is a book which should be read by all our young naturalists, and by all connected with our colleges and schools. It shows what can be done for natural science, education, and Christianity by the earnest labors of a self-denying man, even under the disadvantages of poverty, want of educational privileges, and bodily weakness; and is full of suggestive hints as to the best means of overcoming the difficulties which beset the pursuit of science and education in this country.

* Northampton, Mass., U. S.: Published by Bridgman & Childs, 1863.

Its interest as a narrative and as a study of human nature is also great. Mixed with some pardonable egotisms, it brings before us a vivid picture of the genuine old New England puritan character, in its energy, its stubborn endurance, its rigid honesty and integrity, its horror of debt and dependence, and its quiet enthusiasm,—qualities which, it is to be feared, have somewhat died out in more recent times, and which certainly require culture among the young men of Canada.

We purpose, in the present notice, to give a few extracts illustrative of the early life and character of Dr. Hitchcock, and of his efforts in behalf of natural history, and especially of the museum of Amherst College.

The following extracts refer to the difficulties of his early life:

"One of these circumstances was the comparative poverty of my early condition. It was not absolute poverty, for my father moved among the most respectable of the people of Deerfield, where I was born, and was honored among them especially by being chosen deacon of the Orthodox church, of which he was long one of the strongest pillars. But he had to struggle hard with a trade not very lucrative, to feed, clothe, and educate a large family. He had commenced his family career during the Revolutionary War, in which he had been twice engaged as a soldier, as was his father, who fell a sacrifice to the diseases of the camp. The debts which he contracted when Continental Notes were almost the only money, hung like an incubus upon him nearly all his life, and he was relieved only when his sons were old enough to aid him. But he was highly intellectual in his habits, and studied theology especially, with much success." [Towards the close of his life, as but few sympathized with him in his religious views, the church with which he was connected having passed into other hands, he committed many of his thoughts to writing, and some of the essays and sermons which he left "would do no discredit to educated clergymen."]

"It cannot be doubted that such a father would do all he could for the education of his children. We were first carried thoroughly through the primary school, and then had the advantages of a good academy, as much as we could find time and means to improve. But he could go no farther with any of us—he had three sons. And nothing was before me but a life of manual labor. But as I had a great aversion to being apprenticed to a tradesman, he did not attempt even to teach me his own trade,

that of a hatter. Farming was the only resort, and I worked on the farm—not on my father's, for he had none—but on land hired by my brother—I know not how many years. I liked the employment; but, as I shall state more particularly in a few moments, I had acquired a strong relish for scientific pursuits, and I seized upon every moment I could secure—especially rainy days and evenings—for those studies. I was treated very leniently by my father and brother, who probably did not know what to do with me, but saw plainly that I should not become distinguished as a farmer. My literary taste was also greatly encouraged by a few companions in Deerfield with whom I united in a society, whose weekly meetings we kept up for years, which had a department for debate, and another for philosophical discussion. I always regarded this as one of the most important means of mental discipline that I ever enjoyed.

"But perhaps the most important lesson taught me by my straitened circumstances was habits of rigid economy. I learnt that these were more important than a large income. I learnt the value of money, and that the use of it is one of those talents for which we must give an account. It has made me ever since opposed to any useless expenditure of money in clothing, food, furniture, servants, equipage, journeyings, &c. I have been opposed to large salaries; and am confident, that, if the truth were known, our public institutions, literary, political, and religious, have the greatest real prosperity when their officers' salaries are low; for the temptation to extravagance with an increase of means is well nigh irresistible. I have always felt it to be an imperious duty for the officers of a literary institution, which contains indigent young men, to set an example in plainness in dress, equipage, and living, that they might be encouraged. In respect to books, apparatus, and specimens, and even objects to improve the taste, such as paintings, statuary, and articles of *vertu*, I would counsel as large an expenditure as possible, for that is true economy; and to get large sums for these and benevolent objects is the great purpose of economy in personal expenses. But I have ever found men more ready to call your economy parsimoniousness, than to inquire into the liberality of your benefactions for worthy objects.

"For the formation of a taste for science I was doubtless indebted to my uncle, Major-General Epaphras Hoyt, of Deerfield, a near neighbor. He gave the most attention to military science, on which he published some valuable works, and to which I devoted

myself with considerable interest, especially to fortification, when from fifteen to eighteen years of age. But he was also deeply interested in astronomy and natural philosophy, and these branches became my favorites.' The great comet of 1811, and access to some good instruments for observing it, belonging to Deerfield Academy, gave me a decided bias for astronomy. From the 7th of September, 1811, to the 17th of December, corresponding to the appearance and disappearance of the comet, I was engaged in making observations, not only on the comet's distances from stars, but on the latitute and longitude by lunar distances and eclipses of the sun and moon, and on the variation of the magnetic needle. I gave myself to this labor so assiduously that my health failed, and I well remember that when my physician was consulted he said, 'I see what your difficulty is: you have got the comet's tail in your stomach.' To reduce my numerous observations cost me several more months of study, so imperfect were the means of calculation in my hands. Yet I have sometimes thought, when looking over my record of these observations and the results, that they might almost be worth publication, although much inferior to similar works in the observatories of the present day. Indeed, General Hoyt, under whose direction I labored, and who often aided me in observations, communicated some of them to the American Academy of Arts and Sciences, and they were published by that society. But I experienced great benefit from the work, in the mental discipline it required, and I acquired a strong love for theoretical and practical astronomy. I became, in fact, such an enthusiast in this respect, that I could cheerfully forego every ordinary source of pleasure sought after by young men, in order to gratify this scientific passion.

"But I was destined to a sad disappointment in this, my first scientific love. I had for a considerable time been engaged in the study of Latin and Greek, in the hope of entering the University at Cambridge in advanced standing, and using my eyes upon Greek during an attack of the mumps, a sudden weakness of the eyes came on which compelled me to suspend nearly all study and to change the whole course of my life, abandoning a college course as impracticable, and, for a time, nearly all hope of pursuing science or literature as a profession. I have now struggled with this affliction fifty years; and though for some time past, through the kindness of Providence, it has been much mitigated, it has seemed to be a very serious obstacle to my literary pursuits, and it certainly

has produced much suffering. I am not sure, however, but it has been a merciful check upon my disposition to over-work, and thereby has tended to lengthen out my life and ability to labor. If so, how thankful I ought to be for it!

"But Providence had better things in store for me in a variety of respects, to which this trying failure of my eyes and blasting of my plans and hopes would introduce me. To say nothing of spiritual blessings, new fields of science were thus to be opened to me, where wonders yet more attractive awaited me. My eyes failed in the spring of 1814, and for two years darkness that might be felt rested upon my prospects. Still I could not give up study, and tried all manner of ways to make some progress. In 1816, the Trustees of Deerfield Academy ventured to commit that Institution to my care; where for three years I labored intensely to maintain myself, in spite of a defective education, weak eyes, and poor health. It was at this time that I commenced study for the Christian ministry, having been led by my trials to feel the infinite importance of eternal things, and the duty of consecrating myself to the promotion of God's glory and man's highest good. There, too, at first, chiefly as a means of promoting health, my attention was turned to Natural History. About that time Professor Amos Eaton had been lecturing at Amherst, and we became acquainted with him, and I always regarded him as the chief agent of introducing a taste for these subjects in the Connecticut Valley. Dr. Stephen W. Williams, Dr. Dennis Cooley, and myself, all of Deer field, took hold of mineralogy and botany with great zeal. Dr. Cooley and myself collected nearly all the plants, phenogamous and cryptogamous, in the Valley. Dr. Cooley became an excellent botanist; and even to a recent date, when he died in Michigan, had pursued the subject with zest. Dr. Williams afterwards became Professor of Medical Jurisprudence in the Berkshire Medical School.

"I ought also to state a few facts which formed a part of my education, and which served to diminish the evils of a self-taught course. I have already referred to the benefits which I derived from being for many years a leading member of a debating society. I there had an opportunity to practice extempore speaking and composition, and to acquire facility in philosophical reasoning, probably to a ten times greater extent than does a student in college. It was also an admirable discipline I was compelled to go through when called to instruct in the academy in Deerfield. As there

were always in the school a number who were fitting for college, I found a thorough review of a large part of my classical studies indispensable—not once merely, but over and over again, so that the details have remained in my mind even to the present time, and the same is true of the many other studies one is called to teach in an academy. It was a much more severe discipline than if I had been through college drilling; and I would advise no young man to venture upon it unless driven to it, as I was, by dire necessity.

"The academy owned a very good philosophical apparatus, and I prepared a number of lectures on natural philosophy, which were delivered with experiments before the school, and in the evening before the citizens of the village. This was my first attempt at lecturing.

"But my best mental discipline was connected with the use of the astronomical instruments of the academy. In another place I have described the observations which I made on the comet of 1811, as well as on other heavenly bodies. The subsequent winter was in a good measure devoted to a reduction of those observations; and as I had access to only a few books, I was obliged to calculate by spherical trigonometry many elements which at this day are found in the tables of practical astronomy. The mere effort to form an accurate idea of the numerous spherical triangles I had to construct out of the imaginary circles of the celestial sphere, was an admirable discipline, and their accurate solution not less so."

Much more might be usefully said on this subject; but we turn to his experiences as Professor and President at Amherst College.

"When I joined the College in the winter of 1826, there was no laboratory, no philosophical cabinet, no natural history cabinet, and no chapel. Two dormitory buildings had been erected, and in the fourth story of the most northerly of these (the present North College South Entry) two rooms were thrown together, a platform built on which was placed a small tub-like pulpit, which could be moved off to allow the Professor of Natural Philosophy to lecture one part of the day, and the Professor of Chemistry the other part, taking care to finish before evening prayers.

"On the catalogues for 1825 and 1826 my title appears as Professor of Natural History and Chemistry. The order of these subjects was changed on the subsequent catalogues, and continued thus till 1845. For nearly twenty years I had entire charge of

these two wide fields, except that in 1843 Mr. Sheppard was appointed Lecturer of Agricultural Chemistry and Mineralogy. But it should be recollected that these branches, especially natural history, thirty years ago were but little thought of in this country, and were in fact in comparative infancy. And besides, we had then next to no collections, and a leading object before me was to provide them. Indeed, I may state it as a general fact, that in all the subjects in which I have given instruction in Amherst College, I have been obliged to provide the apparatus, models, and specimens, sometimes with, but more often without, funds, except my private resources. Nevertheless, my first courses of lectures and recitations were nearly as extensive as they have been since. They averaged nearly four exercises per week, or about one hundred and fifty in the year. In particular branches, as new instructors have been appointed, more time has been given. For instance, when Professor Adams took the department of zoölogy he was allowed from thirty to forty recitations and lectures, as was also Professor Clark, though, for what reason I know not, they have since been reduced to ten lectures, which is equivalent to five recitations; for it is common now to put lectures in different departments side by side, so that two shall be equal to one recitation—that is a half day. Even in its infant days, I never gave less than twenty or thirty lectures on zoölogy—say ten to fifteen on mammalogy, ornithology, herpetology, and ichthyology, and ten to fifteen on conchology and the other branches of invertebrate zoölogy; also ten to fifteen on botany. At this day, all those important discussions respecting the distribution of species, their metamorphoses, and the unity of the human species, must require several more lectures, or it is impossible to teach graduates how to defend religion against the assaults of sceptics.

"The title of Professor of Chemistry and Natural History, which I had for twenty years, conveys but an imperfect idea of what I attempted to teach, or rather of the grand object I had in view. That object was to illustrate, by the scientific facts which I taught, the principles of natural theology. This I stated at the commencement of my course, and on other proper occasions. At length when I became President, I took natural theology as the leading title of my professorship. And really the instruction given in the natural sciences in college is scarcely more—often less—than is necessary to understand their religious bearing. But this is their most important use, as it is of all knowledge, and this

thought I made the basis of my Inaugural Address, when inducted into the Presidency. I had endeavored to act on this principle in all my teaching; but now I put it into the form of a professorship, and a richer or nobler field I do not know in the whole circle of science. I called it a Professorship of Natural Theology and Geology, adding this latter science because I have been in the habit of going more into detail concerning it, and because no science equals this in its religious applications.

"It was a deep conviction of the importance of such a professorship that led me to seek its endowment. The manner in which it was secured has already been referred to. Mr. Williston had just agreed to endow a professorship, which was finally called the Graves Professorship, in honor of Mrs. Williston's maiden name, and he offered to give half enough to endow another, if some gentleman could be found to take the other half, and proffer his name to the whole. I immediately communicated with Samuel A. Hitchcock, of Brimfield, and I merely stated the case and told him that as he was childless, I wanted that he should make the Professorship of Natural Theology and Geology his heir, and that so long as I was connected with the College, I would fill the chair, and thus make it a Hitchcock *affair* all round. The conceit struck him favorably, and by return mail the proposal was accepted. Subsequently, through fear that some of his securities might fall below par, he added two thousand dollars more, making the whole endowment twenty-two thousand dollars, which is the largest among the professorships, and the income is almost sufficient to sustain two professors."

The perplexities in the management of a New England College are amusingly sketched as follows:

"There are three bodies of men officially connected with College, at whose meetings the President is expected to preside, and for which his duty is to prepare business. The first is the Trustees, whose meetings, in ordinary times, are only once a year. The second is the Prudential Committee, who look after pecuniary affairs, and almost anything, in fact, needed to be done in the absence of the Trustees. These hold their meetings regularly as often as once a month, and frequently much oftener. The third is the Faculty, who hold a weekly meeting for attending to the discipline and government of the College, considering petitions, and seeing to it that everything is in place and order. Here everything that makes friction or is out of gear, among officers or

students, is developed; and though men who have a knack of throwing off personal responsibility and shirking their duties can go through such meetings lightly, and even jocosely, they often weigh heavily upon the President, who is personally responsible for the proper adjustment and management of the whole machine. Consequently these Faculty meetings, held, as they usually are, in the evening, and sometimes protracted to a late hour, are among the most trying of a President's duties. They often wore very much upon me, especially when followed, as they sometimes were, by the admonition, dismissal, or expulsion of delinquents. In almost every such case, the public sentiment and sympathy in College would be with the offender, however gross his crimes. The same would generally be the case with friends at home, and with the community at large. A college Faculty are looked upon by many as an aristocratic, arbitrary, and tyrannical set, whom every humane man is bound to oppose, and multitudes who never saw even the outside of a college, feel fully competent to sit in judgment upon their acts and to denounce them. It is this outside sympathy with those who are under discipline that does more than anything else to sustain them in their misdeeds, and to encourage the rebellions that are the frequent consequence of college discipline; and it is the necessity of thus going against the popular will, and of encountering reactions as the consequence that may rend the college in pieces, that is more trying to a President than all his literary labors. Even in a Christian college, where is often a sprinkling of some of the most difficult elements to control, he is not unfrequently made to feel that he sits upon a volcano, which, though now quiet, may at any moment become active.

"My epistolary correspondence in the Presidency was peculiarly onerous. I had previously been so much of a *jack at all trades* that I had laid myself open to enquiries and assaults from all classes. The same mail (and I hardly exaggerate the literal fact) might bring inquiries about some point in the theory of temperance —how to employ garnet in making sand-paper—how to reconcile the imputation of Adam's sin with our sense of justice—where to find the best beds of sulphate of baryta—whether I would like to exchange or buy shells, minerals, and fossils—how cheaply an indigent young man can go through the college, and with what helps —whether I knew of any one who would make a good teacher of a common school or of an academy, or a professor in a college, or any one to supply a pulpit—what I thought of a new theory of drift, or

of latent heat—or new views of the relations of geology to Moses—or a new poem—or a new work—all of which were sent, and an answer requested, if possible, by return mail. During my Presidency I calculated that I was obliged to answer as many as four hundred or five hundred letters annually, and to these should be added at least one hundred recommendations to students going out to teach school, and for other purposes, and to graduates."

Along with this we may place the practical difficulties of the Professor of Chemistry:

"I have already given some idea of the state of preparation in the College for chemical experiments when I joined it. Not only was I obliged to lecture in the fourth story and in a sort of chapel, but there were no instruments or ingredients worth naming provided by those who preceded me. For four gentlemen had lectured on that subject before me, viz., Col. Rufus Graves, Professor Olds, Professor Amos Eaton, and a Mr. Cotting, who was afterwards appointed State Geologist in Georgia.

"I must have given at least two fourth-story courses of lectures. But when the chapel building was erected in 1826, an opportunity was presented for fitting up a laboratory. The basement story at the east end was mostly above ground, with cellar rooms adjoining. I had ample space for a large lecture-room, apparatus-room, and office, and means enough were furnished for supplying economically furnaces, cisterns, gasometers, and apparatus. The only difficulty was that the room was beneath all the others, and partially under ground. But at that time the idea generally was that such was the proper place for a laboratory. Because the chemist eliminates many mephitic gases, therefore place him where he cannot get them out of his room; or if they do escape through the ceiling, they will let all in the rooms above him get a whiff of the atmosphere which he is obliged to breathe in concentrated purity. Nevertheless, I spent at least a third of my time for eighteen years in that laboratory, and found it in most respects very convenient. I do not doubt that its dampness and the unwholesome gases which I got rid of only by opening the doors and windows, have contributed to bring on and aggravate those pulmonary and bronchial difficulties that now press so heavily upon me, and will soon terminate my days. But probably a person in good health need not fear *active* employment in such rooms. I have found analytical chemistry to be more trying in such a place than the mere preparation for lectures, because the former requires such long-continued attention."

We reserve our remaining space for extracts from the remarkable history of Dr. Hitchcock's museum; the whole of which is well worthy of being read:

"When I came here, in 1826, a Natural History Society existed among the students, which had begun to bring together specimens chiefly in mineralogy, geology, and mammalogy; but they were too few to be employed in lecturing. I therefore took up the business of collecting. I had, however, in previous years, obtained a few hundred specimens, mostly in mineralogy and geology, and the Trustees in 1826 "voted that Professor Hitchcock be requested to deposit his private geological cabinet in the Cabinet of the College." Previous to this time, I believe, the Natural History Society had presented the whole or part of their collections; so that, so far as numbers were concerned, our cases looked quite respectable. But to one acquainted with natural history, probably the larger part would come under the ironical title of *Jactalites;* that is, specimens to be thrown away. H wever they did a very good service so long as no better collections were near. And it is a fact that some of the ablest naturalists who graduated here (ex. qr. Shepard and Adams), started in these days of meagre scientific illustration. Their fewness led such men to study what we had with more attention, and that awakened the desire to see and possess more; and in these two facts, conjoined with good native talent and scholarship, you have the elements of able naturalists.

"In 1830 I was appointed to make a geological survey of Massachussetts, and this opened a door for the introduction of numerous specimens. The Government, indeed, directed that a collection of the rocks and minerals of the St. e of moderate size should be collected for each of the colleges. They amounted, I believe, in the first survey, to about eight hundred. I also collected four times as many for the State Cabinet, and nearly as many for myself. Having deposited the latter in the Cabinet, the Trustees, feeling under obligation to Williston Seminary, or rather to its founder, presented to it the collection of eight hundred specimens.

"Another way which has been a prolific one of increasing the Cabinet in all its branches, organic and inorganic, is by securing the help of the graduates of the College, especially the foreign missionaries. The Zoölogical Museum has in this way often been enriched. In the Woods Cabinet is a collection of rocks and minerals chiefly from Asia, of more than twelve hundred speci-

mens, sent in a great measure by missionaries, or by men on missionary ground. Many of these specimens possess a special interest from the sacred localities from which they came. But they are numerous enough from some extensive regions to give a tolerable idea of the geology; as for instance Syria and Palestine, especially Mount Lebanon, Armenia, and the north-west part of Persia, and the Ghaut Mountains of India.

"My collection of fossil footmarks was begun in 1835. For as soon as I had turned my attention to Ichnology, I commenced the accumulation of specimens, and from that day to the present I have never ceased to gather in all which I could honestly obtain. For no other part of the cabinet have I labored so hard or encountered so many difficulties. True, for some years at first I had the field essentially, to myself; and had I then been fully aware of its richness and extent, I might have secured a large amount of specimens at a reasonable rate. But the subject opened upon me gradually, and the disclosures made by my writings attracted others into the field who became uncompromising competitors in the way of collecting, and with some it became a matter of trade. The consequence was that the value of specimens rose to almost fabulous prices. The man who had made the largest collection was Dexter Marsh, of Greenfield, who was himself a quarryman, and had the ambition, as he told me, to get together the largest collection in the world. He succeeded, if we take into account the quality of the specimens. But, poor man! he died before his work was done; having, in my opinion, hastened his decease by excessive labor in the hot sun in getting out beryls and other minerals. His executors sold his collections at auction. I knew they would sell high, for I was one of the appraisers, and we marked them high. But I could not see those fine specimens all scattered through the land without making an effort to raise some money to secure some of them, and I adopted this plan. My collection of footmarks had become so large, that, in the opinion of so good a judge as Professor C. U. Shepard, its value was not less than $3,500; and that it could be disposed of for at least $2,000 in cash. In a circular to several benevolent gentlemen, I offered to present this to the College, if others would furnish me with six or seven hundred dollars with which to secure some of the slabs at Marsh's auction. It so happened, or rather, as I view it, Providence so ordered it, that I first addressed John Tappan, Esq. He responded by a subscription of $500. To this extraordinary

liberality I attribute my success in filling up the present large cabinet. For so high a standard had imitators. Hon. David Sears soon added another $500; Gerard Hallock followed with $250, Hon. E. P. Prentice with $150, and several other gentlemen with $100 each. So that I went to the auction with nearly $2,000 in my pocket. Moreover the stream of benevolence which had thus been diverted into this channel did not cease to flow with the Marsh sale; but almost to the present day new and liberal increments have continued to be made to the funds in my hands chiefly devoted to footmarks; so that they have risen to $3,800. Among the donors was the widow of Hon. Abbott Lawrence, who sent me $300, although I suggested as a maximum only $100. Had Mr. Tappan headed the subscription with $50, —and I could not reasonably have expected more,—probably I should have been compelled to see it close at $500, and the Ichnological Cabinet would have been a meagre affair compared with what it is now.

"When I reached Greenfield to attend the auction in September, 1853, I found several naturalists there from Boston with pockets well lined, who came with the intention—as they had a right to do—to take the whole of Mr. Marsh's collection for the Boston Society of Natural History. I told them that there were many duplicates in the collection, enough if divided to supply both the College and their Society. But if they insisted upon monopolizing the whole, I had made up my mind, having $2,000 on hand, to be very *benevolent* towards the widow by compelling them to pay very liberal prices. They seemed to feel the reasonableness of my suggestions, and they found as I stated that there were enough specimens for us both. My bill went as high as $700, and theirs higher.

"Since this auction I have continued to lay out large sums in the purchase of footmarks. To Roswell Field, who lives on the most remarkable known locality, and has disinterred more tracks than any other man, I have paid not far from $4,000. His prices have indeed been generally high, but when the specimen was unique, I must give him what he asked, or leave it for some one else; and Mr. Field has, in at least two cases, presented specimens to the Cabinet which I have estimated at $300.

"To persons not familiar with the value of natural history specimens, the idea of giving $150 for a broken slab of stone a few feet square—I have several specimens that cost me that sum—seems extravagance and folly. I may mention an anecdote in

point. After the auction at Greenfield, I employed a waggoner to transport my specimens to the railroad. I happened to be a little out of sight, and heard him describing to a citizen standing by the sums I had paid for them. 'The man,' said the citizen, 'who will waste money like that, should have a guardian placed over him.' I could not restrain a loud laugh, which brought us into conversation, when I said, 'You will at least acknowledge that my insane prodigality is a good thing for Mrs. Marsh.'

"I must acknowledge, however, that in no enterprise in my life have I been obliged to work so hard, and exercise so much strategic skill to avoid paying exorbitant prices, and even being defeated, as in the collection of this Ichnological Cabinet. The high prices paid at the auction (one slab sold for $375) produced an impression of the great value of these relics throughout the Valley, and exorbitant prices were attached to them wherever found. But very few, however, knew enough about the different kinds to distinguish the rare and valuable ones. But since I had studied them all, I found that wherever I expressed any particular interest in a specimen the presumption was that it was rare, and the price went up accordingly. I was obliged, therefore to exercise a good deal of prudence, and show much *sang froid*, or I could not, with my small means, make much headway. I worked as quietly as possible, with my plans locked up in my own bosom, yet with inflexible resolution and perseverance, looking constantly to God for help. I felt that such a collection would illustrate a curious chapter of His providence towards our globe, and that the larger the collection, the more full the illustration. I expected myself to make only a beginning; but I wanted to provide the means for my successors to carry forward the work which they never could do if the specimens are scattered all over the world, or rather if all the varieties are not found in some one cabinet. Large as the collection now is, I have been often pained to see very fine specimens taken out of my hands by those who could pay more for them than I could, and carried, I know not whither.

"In such circumstances, I have tried to be as economical as possible in the use of the money in my hands for this purpose. Whenever I could, I have myself gone to the quarries and dug out the specimens. When not too large, also, I have transported them on my own business-waggon. Again and again have I entered Amherst upon such a load; generally, however, preferring not to arrive till evening; because, especially of late, such manual labor

is regarded by many as not comporting with the dignity of a professor. I have not however, in general, paid much attention to such a feeling, except to be pained by seeing it increase, because its prevalence would change the character of the College, by driving away those who are obliged to do their own work.

"During these twenty-six years' experience in gathering these footmarks, I have met some very unique examples of human nature. While some of my countrymen in the lower classes of society have shown a shrewdness and generosity and made me feel proud of New England, others have exhibited a selfishness and meanness that made me exclaim, *Parvum parva decent!* For instance, suppose on your arrival at a locality of footmarks, one had preceded you with whom you were on friendly terms, but who was so anxious to prevent your obtaining any specimens, that he had mutilated the good ones that were accessible, which he had not time to remove! Alas, if I had not known this vandalism practiced several times by professedly respectable naturalists, I should not mention it.

"Some of my experiences have been quite amusing. Having found some impressions which I called tracks (*Harpagopus Hudsonius*) in the sidewalks of Greenwich Street, in New York city, I requested a moulder to take a plaster cast of them, which he did. But on going to the spot again some hours later, I was told that some one else had meantime taken casts of them! although he could not have known that they were of any value; but it shows how prone men are to follow an example. A large crowd had gathered when I took the first cast; and I was told afterwards that all which saved me from being voted a fit subject for a lunatic asylum, was the testimony of a young lady, in one of the adjoining houses, who had attended my lectures on geology at Amherst, and who testified that I was no more deranged than such men usually are."

These are but specimens of the enthusiastic work of a lifetime, which occupies in the narrative no small portion of the book. The results are very marvellous, even when we take into account the credit due to Profs. Adams and Sheppard, and others; all of which is acknowledged by Dr. Hitchcock. The museum, as it now stands, is one of the finest in America, and, in some respects, as in phonolites and meteorites, second to none in the world. It is valued at more than $100,000, and has been collected at an expense to the College almost nominal.

A useful purpose will be served in this country, where such things are as yet too little appreciated, by quoting Dr. Hitchcock's estimate of the utility of natural history collections.

"1. They are indispensable to give students a knowledge of the natural productions of different parts of the earth; and without which, their views would be narrow, and they would be liable to constant blunders in their literary productions.

"2. When studied, they help very much to sharpen the discrimination, and teach students how to distinguish between the apparent and the real. Indeed, as a means of mental discipline, no branch of knowledge goes before natural history; though, from the very limited attention usually given to such subjects, this effect is but slightly realized.

"3. They are indispensable, also, to give facilities to any students who have a natural taste and fitness for such pursuits, to qualify themselves for future distinction in them; and this they can do, if the collections are good, without interfering with recitations in other branches, by devoting those leisure hours to the cabinets, which most give to useless recreation or to something worse.

"4. They deeply interest and instruct the community surrounding a college, and all who visit it, and thus give reputation to it. Visitors cannot be shown much in mathematics, or in the classics, as they pass through college-halls, unless particularly well acquainted with the subjects, and even large libraries are all seen at a glance. But almost every one will see enough in nature's products to awaken interest, inquiry, and admiration. This explains the fact that as many as fifteen thousand visitors annually have registered their names in the Amherst Cabinets, small and retired as the place is. The College could not afford to lose the influence in favor of the institution thus spread through the country. It turns the attention of many young men to this place; and when they learn that in all other respects the institution stands high, this feature often brings them here, in spite of the claims of rival colleges. This is not indeed the most important thing in the College; but we need to combine all the influences that we can to enable the College to maintain the high position it has taken, and to continue its upward course.

"5. These cabinets form an anchor to steady the College in stormy times. Such periods of trial not unfrequently come, when the temptation is to give up the ship, or transfer it to to some other

place. But though it be easy to transfer able teachers and funds, and even libraries, large cabinet buildings, with costly fixtures, cannot so easily be changed; and the friends of the College would be quite apt to rally around the fruit of seventy-five years of labor which they contain, since mere money cannot make their place good.

"6. These cabinets are indispensable to teach young men how to defend and illustrate religion. This is their most important use. For I hesitate not to say, that, however otherwise well educated a scholar is, he cannot defend Christianity, or even natural religion, from the subtle attacks which of late years have been drawn from natural history, from geology and zoölogy. For instance, if he has not seen, and to some extent studied the specimens on which these objections are founded, he must see and examine rocks and fossils before he can understand the discussions raised by geology on the age of the world, on the eternity of matter, on the pre-adamic existence of suffering and death, on special Divine interventions in nature, and on the extent of the deluge. He must study animals and plants, or he cannot refute the advocates of the development-hypothesis or of the plurality of origin of the human species. Where else but in college can those who mean to be ministers of the Gospel acquire such knowledge? Surely not in our theological seminaries, nor in the families of private clergymen. The abstract, metaphysical way of treating those subjects which they may learn elsewhere, will only excite the ridicule or contempt of the able, sceptical naturalist.

"On the other hand, it is only by the study of cabinets that theological students can learn how to use with ability those numerous illustrations and confirmations of religious truth which of late years have been derived from natural history. The larger part and the most striking of the proofs and illustrations regarding the Deity and his attributes, have been derived from this department of knowledge. It is a rich field, and furnishes, besides the case just indicated, numerous striking confirmations and illustrations of some of the most precious truths of revealed religion, as the works of McCosh, Hugh Miller, Dana, Harris, Chalmers, and many others show.

"7. Finally, large cabinets are necessary to enable instructors to make new discoveries in science, and to trace out new religious illustrations. With small collections, the prospect of finding undescribed objects would be small. And in this fact, not in want of ability, do we see a reason why so few professors of natural

history add many new facts to their departments, or suggest new illustrations of religion. True, the want in our libraries of the great standard books on these subjects published in Europe, is another almost equally powerful obstacle to new discoveries, as the want of specimens. But what a pity that in both these ways our professors should be deprived of a credit they ought to have the power to attain, and be compelled to put into the hands of European naturalists every object apparently new which they meet, because they are afraid to describe it, lest it should have been already described by transatlantic naturalists!

"It is for such reasons that I felt justified in devoting so much time and effort during thirty-eight years, to build up and fill the Cabinets at Amherst. I have no expectation or wish to give the subjects of natural history here an undue prominence, but only to make them subserve the objects I have specified, and to do something towards sustaining the credit and popularity of the institution."

NOTES ON THE HABITATS AND VARIETIES OF SOME CANADIAN FERNS.

By David R. McCord, B.A., Montreal.

Polypodium vulgare.—Common in Lower Canada; eight to twelve inches long, occasionally smaller. As it grows upon rocks, it may sometimes be seen curled up by drought. I have not yet observed any abnormal forms; but since in Great Britain there are, according to Lowe, thirty-seven varieties more or less constant in cultivation, attention to this fern is particularly to be desired from Canadian pteridologists. Montreal, not common; Chatham; Waterloo; Sorel, Lady Dalhousie; Temiscouata, common, J. G. Thomas, M.D.; Quebec, Hon. William Sheppard. White Mountains, New Hampshire.

Polypodium hexagonopterum.—Usually thinner, less coriaceous than *P. Phegopteris*. Waterloo; Chatham; Sorel, Lady Dalhousie; Quebec, Hon. William Sheppard.

Polypodium Phegopteris.—Rhizoma many rooted, stipes ascending at short intervals; occasionally sixteen inches in height, (including stipe). Temiscouata, common, J. G. Thomas, M.D.; Waterloo; Lennoxville; Chatham; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Rev. Prof. Brunet.

POLYPODIUM DRYOPTERIS.—Rhizoma black, few rooted. Montreal, not fine; Waterloo; Lennoxville, very fine; Chatham; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Hon. William Sheppard; Temiscouata, common, J. G. Thomas, M.D.: White Mountains, New Hampshire.

β. erectum.—I have a specimen which appears to correspond with this variety, fifteen inches high and nine inches broad, but its size is the chief difference I can detect between it and the normal smaller specimens. The pinnæ are however more deeply pinnatifid, and, in the case of the lowest ones, almost pinnate. Waterloo, June 6, 1862.

POLYPODIUM ROBERTIANUM.—Sorel, Lady Dalhousie.

ADIANTUM PEDATUM.—When it first appears in spring, in the early part of May, the stipe is covered with thick chaffy scales, and the frond circinate; the scales soon disappear, and in a week or two the stipe is at full height. Common almost everywhere in Lower Canada. Montreal; Lennoxville; Waterloo; Chatham; Sorel, Lady Dalhousie; Quebec, Hon. William Sheppard; Durham, Wickham and Melbourne, John A. Bothwell, B.A. White Mountains, New Hampshire.

Var. triangulare. — From Chatham, where a large clump grew. Very deep green, fewer pinnæ (branches) than normal, and fewer pinnules; these more deeply pinnatifid, sometimes divided half way to the midrib at back. Instead of the common oblong-shaped pinnules, this variety displays a triangular form, and the whole aspect is in a measure different.

PTERIS AQUILINA.—Common everywhere in Lower Canada. Montreal; Waterloo; Chatham; Lennoxville; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J. G. Thomas, M.D.; Sorel, Lady Dalhousie. White Mountains, New Hampshire; Portland, Maine.

The varieties of this fern are very numerous. *Vars. a. vera* and *β. integerrima.* I have collected specimens of both these varieties, though they do not adhere exactly to Dr. Lawson's descriptions of them. I have also one or two beautiful specimens of another variety, with a brown stripe of six and a half inches in length, surmounted by the frond, which is three inches high, and three and a half broad. The branches are pinnate, the pinnæ pinnatifid and very clearly divided. The specimens were minutely chaffy-hairy and in fruit. Now the *vars a. vera* and *β. integerrima* are of large size, and not so thick or coriaceous, though

they agree with this variety in the number of branches and in point of pinnatification. Whether specimens of this variety in a sterile state would be less coriaceous, I am not in a position to say. These last mentioned specimens were collected at Chatham on the Ottawa, a locality rich in ferns; and I may also add, in phœnogamous plants. I have also another variety of *P. aquilina* displaying extremely lanceolate pointed pinnules; but whether this acuminate property be constant, I cannot now affirm.

ALLOSORUS GRACILIS.—Rare. Rocks, county of Prescott, C. W.; on the shore of River Ottawa, opposite the residence of Lemuel Cushing, Esq.; Chatham; Cacouna, very fine specimens, Dr. J. W. Dawson; Rivière du Loup (en bas), J. G. Thomas, M.D.; near Britannia Mills, rare, Hon. William Sheppard; Murray Bay, R. Anstruther Ramsay, B.A.

STRUTHIOPTERIS GERMANICA.—Very common. Among other localities:—Montreal; Waterloo; Lennoxville; Chatham; Sorel, Lady Dalhousie; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; along the Green River, J. G. Thomas, M.D. White Mountains, New Hampshire.

ONOCLEA SENSIBILIS.—A very variable and interesting fern. Of many barren specimens some are deeply pinnatifid, which appears the normal state, or with the last pair of divisions almost pinnate; but in every case that I have yet observed there is a wing, however minute, upon the rachis, so that we cannot properly apply the term pinnate to this fern. I have several sterile varieties, one covered with glands, another in which the properties of the sterile and fertile are seen in the same frond, as may be observed in pinnules of *Osmunda regalis*, var. *spectabilis*. Some are contracted and deeply pinnatifid; one obtusely terminated at apex and at ends of divisions. Whether these would be constant under cultivation I cannot say, as I have not had time to investigate this fern sufficiently, and have only mentioned these varieties as a stimulus to observation. On the whole it would appear that from the earliest development of *Onoclea* there are two general forms. One from the multiplication of wavy-toothed divisions, the other by the development of lanceolate-triangular divisions; under these may be included all the abnormal forms which I have seen. Common. Montreal; Sorel, Lady Dalhousie; Waterloo; Chatham; Lennoxville; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J.G. Thomas, M.D.; White Mountains, New Hampshire; Portland, Maine.

ASPLENIUM VIRIDE.—Gaspé, John Bell, B.A. A very interesting little fern. From the specimens that I have seen, though not from the above-mentioned locality, it may be distinguished from *A. Trichomanes* (among other differences,) by having a green rachis, and a dark colored stipe, while *A. Trichomanes* bears a stipe and rachis of dark shining blackish-brown. In *A. viride* the fructification occupies more of the surfaces of the pinnæ, and they are less numerous.

ASPLENIUM TRICHOMANES.—Chatham, on rocks, in large clumps; observed in no other locality in Lower Canada.

ASPLENIUM ANGUSTIFOLIUM.—Very beautiful, not common. Montreal, larger and smaller mountains; open woods, in company with *Lastræa Goldiana;* Sept., 1863. Observed specimens with a bifurcation at apex, as in some British varieties of *Polypodium* and also of *A. Felix-fœmina.*

ASPLENIUM THELYPTEROIDES.—Montreal; Waterloo; Lennoxville; Chatham, and northward to Wentworth, Harrington, Howard, and Arundel; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A. Portland, Maine; White Mountains, New Hampshire.

β. serratum.—Very fine, Chatham.

ATHYRIUM FELIX-FŒMINA.—Common, Montreal; Chatham, and northward; Lennoxville; Waterloo; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, very common, J. G. Thomas, M.D. White Mountains, New Hampshire; Portland, Maine. I have a variety or two, agreeing in some respects with *β. erectum,* and also with *γ. rhœticum,* but would not presume to identify them, as I have not studied the varieties of this fern.

CAMPTOSORUS RHIZOPHYLLUS.—Rare; dry rocks at l'Abord-à-Plouffe, on the river Jesus, rear of the island of Montreal; but not easily found even there. St. Helen's Island, rare, Hon. William Sheppard; Sorel, Lady Dalhousie, as *Asplenium rhizophyllum.*

LASTRÆA DILATATA.—(*Aspidium spinulosum,* of Gray's Manual.)—I have many specimens of this most variable species from those short both in stipe and frond, and triangular, the pinnules being deeply toothed or lobed, hardly pinnatifid, to those that are broadly lanceolate, spreading or not, and finely cut. I cannot, however, identify *β. tanacetifolia* with any of them. I have the var. *Boottii* (of Gray's Manual), with glandular indusium. I also found

at Waterloo, June 5th, 1862, a contracted, depauperated, though tall, specimen of *L. dilatata*, which bore indusia thickly covered with glands, stalked, and many furnished with a funnel-shaped head. In this case the pinnules were curved towards the back of frond, and these glands were also thickly scattered over the front and the back of the pinnæ. The abnormal appearance of this specimen induced me to examine the front of the frond for glands, and in other specimens they might perhaps be discovered similarly situated, if search were made. This fern requires careful study. Montreal; Chatham; Lennoxville; Sorel, (?) Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, common, J. G. Thomas, M.D.; Quebec, Rev. Prof. Brunet. White Mountains, New Hampshire; Portland, Maine.

LASTRÆA MARGINALIS.—Common. Montreal; Chatham; Lennoxville; Quebec, Hon. William Sheppard; Sorel, Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J. G. Thomas, M.D. White Mountains, New Hampshire; Portland, Maine. I do not know the var. *β. Traillœ*, which must be very handsome. I have two specimens of a small variety (eleven inches long), with few pinnæ, where the apex is composed of a pinna instead of the ordinary mode of growth; similar in style to the top of *Polypodium vulgare*, var. *crenatum* (Moore), or var. *semilacerum*. I do not think this variety is constant. Another variety displays only three pinnæ in a slightly circular form. Montreal, 1863.

LASTRÆA CRISTATA.—Not uncommon. Montreal; Chatham; Lennoxville; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A. I am inclined to think, that, from a number of specimens I possess, there is a variety of this fern, larger, broader, the pinnules less triangular, more lanceolate and more scythe-shaped than the normal, and, from their size and their position, not to be referred to *L. Goldiana*. It is a handsomer fern than the common *L. cristata;* and intermediate forms may be traced between this variety and the triangular-pinnated specimens. Chatham, C. E.

LASTRÆA GOLDIANA.—I think my specimens may be referred to var. *a. serrata*, but cannot speak certainly, as I have only observed the fern in one spot, near Montreal; and the sori are larger than in any other fern we have, which bears an indusium; whereas Dr. Lawson says the sori are small. My barren fronds are smaller than the fertile. Montreal, smaller mountain, with

Asplenium angustifolium. Durham, Wickham, and Melbourne, John A. Bothwell, B.A.

LASTRÆA THELYPTERIS.—Common. Montreal, very fine specimens; Chatham; Waterloo; Sorel, Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Rev. Prof. Brunet. White Mountains, New Hampshire; Portland, Maine.

LASTRÆA NOV-EBORACENSIS.—Montreal; Waterloo; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.

POLYSTICHUM ANGULARE.—*β. Braunii.* Quebec, Hon. William Sheppard, as *P. aculeatum.* Temiscouata, not common, J. G. Thomas, M.D.

POLYSTICHUM ACROSTICHOIDES.—Montreal; Waterloo; Chatham; Lennoxville; Sorel, Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Hon. William Sheppard.

β. incisum.—Montreal, July 24th, 1861.

CYSTOPTERIS FRAGILIS.—Montreal; Shefford Mountains, near Waterloo, in one spot only; Chatham, very fine; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Rev. Prof. Brunet. My specimens from Montreal measure about ten inches in length, three of which are stipe; narrowly lanceolate, not more than one and a half inch in breadth; while those from Chatham are much finer, being eight inches long, exclusive of stipe, three inches broad, bi-pinnate, pinnules incised, and, like the ordinary specimens, the pinnæ are not approximate. This constitutes, I think, a variety. Those from Waterloo are more triangular, thinner, pinnæ more approximate, but are twice pinnate, hence they cannot be referred to Mr. Bell's specimens, whose pinnæ are not pinnate. This fern requires careful study.

CYSTOPTERIS BULBIFERA.—Montreal; Chatham; Waterloo, rare, only one clump seen; Quebec, at the Falls of Lorette, north declivity of the river, Hon. William Sheppard; Upper Falls of the Rivière du Loup en bas, variable in outline, J. G. Thomas, M.D.; Sorel, Lady Dalhousie.

DENNSTÆDTIA PUNCTILOBULA.—Said to be at Long Point, near Montreal, but I cannot vouch for it. Sorel, Lady Dalhousie; Dalesville, near Chatham; Lennoxville; Waterloo; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A. Portland, Maine; White Mountains, New Hampshire.

WOODSIA ILVENSIS.—Montreal; Chatham; Wolfe's Cove, Quebec, Hon. William Sheppard; Lachute; Rivière du Loup en bas, on rocky banks, J. G. Thomas, M.D.; Sorel, Lady Dalhousie.

β. gracilis.—If I have this variety, as I am disposed to think, the pinnæ and pinnules are both more lanceolate, and more covered with chaffy scales, as mentioned by Dr. Lawson; the stipes are also not so dark in color.

WOODSIA GLABELLA.—Montreal? very rare; Chatham; rare, at the Upper Falls of the Rivière du Loup en bas, J. G. Thomas, M.D.

OSMUNDA REGALIS, var. *β. spectabilis.*—Montreal; Waterloo; Chatham; Lennoxville, rare; Quebec, Hon. William Sheppard; Sorel, Lady Dalhousie, as *Osmunda regalis;* Durham, Wickham, and Melbourne, John A. Bothwell, B.A. I also noticed this fern in the White Mountains, New Hampshire; Portland, Maine. It is common in this fern to observe a pinnule partly in fruit and partly barren.

OSMUNDA CINNAMOMEA.—Montreal; Chatham; Waterloo; Lennoxville; Quebec, Hon. William Sheppard; Sorel, Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J. G. Thomas, M.D. Portland, Maine; White Mountains, New Hampshire.

OSMUNDA CLAYTONIANA.—Variable in size. Montreal; Lennoxville; Waterloo; Chatham; Sorel, Lady Dalhousie; Quebec, Hon. William Sheppard; Temiscouata, J. G. Thomas, M.D. White Mountains, New Hampshire; Portland, Maine.

BOTRYCHIUM VIRGINICUM.—Common. Montreal; Chatham; Waterloo; Quebec, Hon. William Sheppard; Lennoxville; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J. G. Thomas, M.D.

γ. simplex.—Montreal, July 28th, 1861; Quebec, Rev. Prof. Brunet; Temiscouata, rare, near the sea-shore, J. G. Thomas, M.D.

BOTRYCHIUM LUNARIOIDES.—Rather rare. Montreal; Sorel, Lady Dalhousie, as *B. fumarioides;* Quebec, Hon. William Sheppard, rare; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.

My specimens hardly agree with Dr. Lawson's division of this fern. One, with barren branch bi-pinnate and fertile branch bi-almost tri-pinnate, would appear to agree with *B. lunarioides;* another with a large, tri-pinnate fertile frond, agrees in this respect

with *B. obliquum*, but not in the barren frond, which, although bipinnate, has not narrower divisions. They are simply more coarsely crenate and more coriaceous. This may of course be not at all *B. obliquum* of Dr. Lawson, and I had regarded it as a variety of the *B. lunarioides*. I can add nothing further, as I have not seen many specimens of this fern. I have a variety of it collected at Lake Memphramagog, C E., in 1862, by Mrs. J. H. Thompson, which would be in the same relation to *B. lunarioides* that the variety γ. *simplex* is to *B. Virginicum*. The sterile branch is almost twice pinnate, with few wedge-shaped minutely-toothed lobes; the fertile branch is also almost or entirely twice pinnate: but the whole specimen has this peculiarity, that instead of there being three barren branchlets, and one fertile, there are three fertile and one barren.

Botrychium Lunaria.—North side of Island of Orleans, J. F. Whiteaves, F.G.S.; and Rivière du Loup en bas.

Ophioglossum vulgatum.—Melbourne, C. E., where exceedingly fine specimens are to be found, Miss Isabella McIntosh, Burnside House, Montreal. This fern, with the *Botrychium Lunaria* mentioned above, are now for the first time recorded as being natives of Canada proper.

The above brief statement of the Lower Canadian ferns, intended as a supplement to Dr. Lawson's valuable paper, includes thirty-seven species, to which, if we add the six additional ones which are as yet peculiar to Upper Canada, we have a total of forty-three species of Canadian ferns. I enumerate the six above alluded to.

Pellæa atropurpurea, Link.

Cryptogramma acrostichoides, R. Brown.

Asplenium ebeneum, Aiton.

Woodwardia Virginica, Willdenow.

Scolopendrium vulgare, Smith.

Polystichum Lonchitis, Roth.

There are, then, in Canada almost as many species of ferns as in Great Britain, and much is yet left for observation, particularly in Lower Canada,—where other species may, perhaps, be discovered; and we have also the investigation of varieties to interest us.

There are forty-nine species mentioned by Gray as being in the northern United States; and of these a good number, as *Lygodium palmatum*, Swartz, *Schizaea pusilla*, Pursh, and others, are not

to be looked for in Canada, from its northern position. On the other hand, Dr. Lawson's lists include *Asplenium viride*, Hudson, *Botrychium lunaria*, Swartz, and others which are beyond Gray's stated limits, (see page 263). Should we, then, not find some Canadian ferns recorded by Gray or other American authorities, we must look to other countries of the same latitude, elevation, &c., as ours. Taking a general view, more than half of the Lower Canadian ferns are inhabitants of tracts of country not dry; they are found in open meadows, or swamps; the remainder grow upon rocks, with little moisture, as *Woodsia Ilvensis*, *Cystopteris fragilis*, (occasionally,) *Allosorus gracilis*, &c.; or upon rocky positions but requiring moisture, in which case they suffer during dry seasons, as *Asplenium Trichomanes*, &c. Not a few grow in either dry or damp positions, in shade or sunshine, when different varieties may be looked for; while a change of habit, such as is produced by clearing land, proves fatal to some species. A northern aspect is also sometimes noticed. What the progress of civilization may do in affecting the ferns, time will evince, as I have noticed ferns slowly disappearing; though the loss of species will of course require long lapses of time. For instance, have we any record what were the ferns of Europe, or of Great Britain, some centuries ago?

With regard to Quebec, one of the localities indicated in the above notes, the Honorable William Sheppard, who kindly furnished me with a list of the ferns to be found there, is disposed to think that some more species than he has named might be discovered. He was guided by notes, and by memory, as his own collection was unfortunately destroyed by fire some years ago.

ON THE FOSSILS OF THE GENUS RUSOPHYCUS.

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

The genus *Rusophycus* was established by Prof. Hall for certain transversely wrinkled impressions found in the Clinton group of Oneida County, New York, and supposed to be fossil sea-weeds. Objects of similar appearance have been detected by Mr. Billings in the Chazy sandstone of Grenville, and described by him under the name of *R. Grenvillensis*. They much resemble one of Prof. Hall's species, *R. bilobatus*, which is the type of short bilobate forms included in the genus. Similar markings, but of much smaller size, occur in the Lower Carboniferous of Nova Scotia, and have been described and figured by the writer as probably casts of the lower extremities of worm-burrows, in the *Journal of the Geological Society of London*, vol. xiv, p. 74. In the 12th volume of the same journal, Mr. Salter had described small bilobate impressions, not striated transversely, from the Longmynd rocks of England, under the name *Arenicolites didyma*. He supposed them to be burrows of worms.

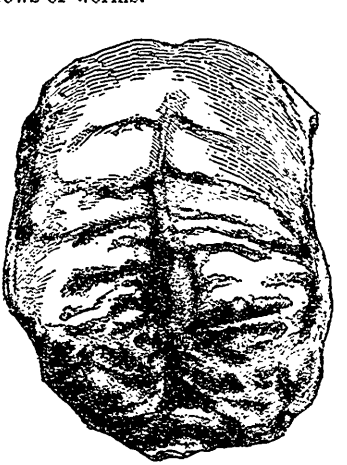

Fig. 1. *Rusophycus Grenvillensis*, var. *a*, half nat. size.

I had an opportunity last summer, in company with Mr. J. A. Bothwell, B.A., to examine the locality of the Grenville specimens, and found them to be quite abundant in certain layers of sandstone alternating with shale on the bank of the Grenville canal. The facts obtained from their study in place enable me to throw some light on their probable nature, and possibly to rescue them

from the convenient group of fucoids, into which palæontologists have thrown so many obscure and doubtful fossils.

Mr. Billings describes the species as follows:

"This species is found in the form of irregular, oblong-ovate or depressed hemispherical masses, one end usually divided into two

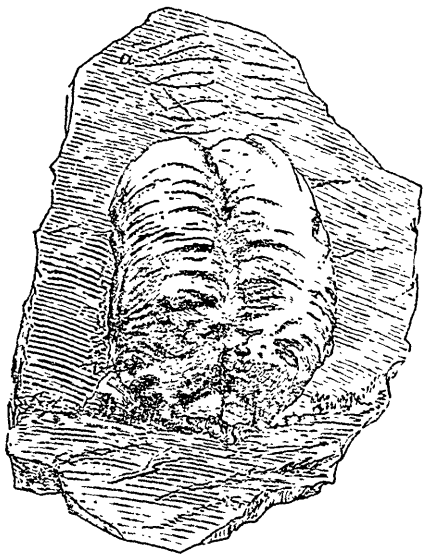

Fig. 2. *Rusophycus Grenvillensis*, var. *b*, half nat. size.

parts by a furrow of more or less depth. The whole mass is generally crossed by numerous undulating wrinkles, which have a transverse direction to that of the furrow. The more common dimensions are from three to four inches in length, and from

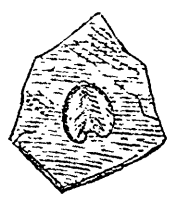

Fig. 3. *Rusophycus carbonarius.*

two and a half to three and a half in breadth, but occasionally specimens occur much larger and also smaller; one of them is nine and a half inches by five and a half, and, in addition to the principal groove, exhibits two or three obscure furrows on each side."

To this description it is only necessary to add, that, in comparing a large number of specimens, many diversities are apparent in the relief of the forms, in the extent of the longitudinal furrow, and in the number of the transverse wrinkles. The two lobes are also most frequently slightly unequal in their relief; and some of the specimens slope gradually at one end, and are thus somewhat elongated. In all cases, however, the general form is the same, the longitudinal and transverse furrows are constant, and the former is always more strongly marked at one extremity of the fossil. The specimens have no indication of a stem or stalk; though a cast of a worm-burrow or shrinkage-crack sometimes simulates such an organ.

In viewing these fossils and the surfaces of the beds containing them, it appeared evident that they are in reality casts of hollows or holes excavated in clay, and filled with sand which has taken and retained in its consolidated state the impression of their forms. The supposed fossils project from the lower surface of the sandstone, where this rests on friable, dark grey shale. They have the same appearance with the surfaces of the beds of sandstone, and show no traces of organic matter. There are on the same surfaces casts of worm-tracks, also in relief, and which sometimes extend over the specimens of *Rusophycus*. There are also on these surfaces rows of wrinkles, or casts of furrows similar to those of *Rusophycus;* and some of these form trails to or from the ends of the latter. (Fig. 2, a.) Casts of shrinkage-cracks in relief, also occur on the same surfaces. Large specimens of *Rusophycus* sometimes overlap small ones in such a manner as to show that they must have been scooped out of the clay. On the other hand, if the supposed fucoids were really of that character, they must have been solid masses or vesicles, and in the former case must have left some trace of organic matter, while in the latter they could scarcely have impressed themselves so deeply on the clay.

These appearances can, I think, be explained on the supposition that some animal crawling on the soft mud at the bottom of shallow water, by means of feet which made a double series of transverse marks, was in the habit of excavating deep burrows for shelter or repose, and that these burrows were filled with drifted sand constituting the lower part of what is now a thin bed of dark-colored sandstone. The burrowing of the modern *Limulus*, as described by the writer in vol. vii of this journal, would produce a similar effect. I have not seen the burrows of *Limulus* in clay;

and in sand a quantity of this material is thrown out behind, which in a cast would have left two hollows, not present in the fossils; but should a *Limulus* burrow in fine mud, which would become diffused or washed away as thrown out, then the appearance would be not unlike that of these fossils. The front of the carapace would give the rounded, anterior end; the two rows of walking and swimming feet would form the depressions with transverse striæ; and the only addition would be the mark of the caudal spine of *Limulus*, of which there is no trace in the fossils. The animal required would therefore be a crustacean, having feet and habits of life generally resembling those of *Limulus*, but without a caudal spine. The only known animals of the period that could have fulfilled these conditions are the Trilobites; and since the interesting discovery, by Mr. Billings, of the feet, or bases of the feet, of *Asaphus*, the objection to this view which might have been taken from our ignorance of the feet of these animals, no longer exists. The feet of *Asaphus*, in short, appear to constitute just such a double series of laminæ as would necessarily produce markings like those referred to.

From the great depth of these burrows, and the indications of shallow water in the vicinity of a shore presented by the shrinkage-cracks, I would further consider it probable that these holes were places of incubation; and that the Trilobites carried their spawn attached to their swimming-feet, and were in the habit of resorting to shallow water for the purpose of incubation.

The above remarks apply more especially to *R. Grenvillensis*. I can speak with less confidence of Professor Hall's species; but the only specimen which I possess of the *R. bilobatus* of New York, differs from the Grenville specimens only in the proportions of length and breadth; as might be expected, if, as is probably the case, it is the track of a different species. My bilobate impressions from Nova Scotia have been produced by a small animal; perhaps the little species of *Phillipsia* which occurs in the same formation. Mr. Salter's *Arenicola* from the Longmynd wants the transverse markings, and the impressions are somewhat separate, so that they may be of a different character from the others. I think it quite likely, however, that the more elongated species of *Rusophycus*, in the Clinton of New York, may be casts of tracks of Trilobites, and I have long believed that a similar explanation will apply to some at least of the supposed fucoids known as *Arthrophycus*.

Taking his view of the origin of these singular objects, I would suggest to change the generic name of the Grenville fossil to *Rusichnites*. In such impressions it is scarcely to be expected that good specific characters can exist. I think it probable, however, that the Grenville specimens may indicate the presence of three species of Trilobites. Some of the smaller specimens are more elongated than the others, and have more numerous furrows. Other and larger ones are shorter and with fewer and more obtuse transverse furrows. A third variety is that referred to by Mr. Billings in his description, as having traces of lateral longitudinal furrows. These may in the meantime be included under *R. Grenvillensis*, Billings, as varieties (*a*), (*b*), and (*c*). (Figs. 1 and 2).

My Nova Scotia specimens, though small, show little difference of character, but I would regard them as constituting a distinct species, under the name *R. carbonarius*. (Fig. 3).

A third species of *Rusichnites* has recently come into my possession, in a collection of fossils from the coal formation of Sydney, Cape Breton, sent to me by my friend Richard Brown, Esq. These impressions are, like the others, casts in relief, on a slab of sandstone. Each impression consists of the casts of contiguous rounded furrows, each about one-eighth of an inch in breadth, and crossed by curved undulations and striæ, in such a manner as to give the appearance of a pinnate leaf carved in high relief. At each side of these impressions, and about a tenth of an inch distant from them, are interrupted lines, in relief in the casts, and running parallel with the casts of the furrows. The whole has exactly the appearance of the track of the swimming feet and edges of the carapace of a small *Limulus*, about half an inch wide. The tracks have also the same tortuous character with those of the modern Limulus. *Limuli* have not yet occurred in the coal formation of Nova Scotia, though they occur in rocks of this age elsewhere; but from these tracks I infer that animals of this kind lived in the Sydney coal field, where their remains will probably hereafter be found. I propose for these impressions the name *R. Acadicus*, and will endeavor to figure them in the next number of the *Naturalist*.

ON THE GEOLOGY OF EASTERN NEW YORK.

By Professor James Hall and Sir William E. Logan.

Professor James Hall and Sir William Logan spent a few days together last summer in examining some points of the geology of Eastern New York, and propose to continue their examinations next season, when we may expect from them a detailed account of their results. Their principal object was to compare the rocks of that region with some of those of Eastern Canada; and I have now permission, in the absence of these gentlemen, to lay before this Society some of the results of this exploration.

The shales of the Hudson River group, which are seen for a considerable distance north and south of Albany, disappear a few miles east of the Hudson, and are succeeded by harder and coarser shales, sometimes red or green in color, and passing into green argillaceous sandstones. These various strata, which are associated with concretionary and shaly limestones, are now recognized as belonging to the Quebec group. The line of contact between this and the much more recent Hudson River group has nowhere been clearly seen in this region, but the two series are readily distinguished by their differences in color, texture, and hardness,—differences which were formerly supposed to depend upon the partial metamorphism of the eastern portion, when this was looked upon as a part of the Hudson River group. The green sandstones and conglomerates of Grafton Mountain, formerly looked upon as a portion of the Shawangunk conglomerate, are recognized as belonging to an outlying portion of the Sillery formation. This mountain Professor Hall had found in a previous exploration (1844–45) to have, at a point farther south, a synclinal structure, and it probably lies in three low synclinal axes. The Sillery formation scarcely extends south of Rensselaer County.

Canaan Mountain is also apparently synclinal, and, while limestones appear in the valleys on each side of it, consists chiefly of slates, the highest beds being a hard green sandstone, sometimes shaly, without any of the conglomerates of the Sillery; although boulders and angular fragments of these are found in the adjacent valleys. To the east of this, Richmond Mountain, in Massachusetts, presents in its upper portion a compact green slate, passing upwards into a harder rock similar to that of the summit of Canaan Mountain. To the southward, as far as Hillsdale, the

sparry limestones of the Quebec group appear in the valleys, while the hills are of slate. Proceeding thence westward towards the river, only the lower portions of the Quebec group are met with, until we come upon the rocks of the Hudson River group.

Washington Mountain is also of slate, flanked by limestone, all of the Quebec group, and is probably synclinal in structure. The valley to the south of the mountain exhibits limestones, apparently alternating with slates. Columbia and Dutchess counties appear to be mainly occupied by the shales of the Quebec group, with broad exposures of its limestones, until we approach the river to the westward, when the shales of the Hudson River group are met with, extending a considerable distance below the city of Hudson.

From Fishkill the explorers proceeded to Coldspring, crossing what Mather called the Mattewan granite, but which they found to be an altered sandstone. Soon after this they came upon the great gneiss formation of the Highlands of the Hudson, which continues beyond Peekskill. They failed to find the sandstone described by Mather as coming out at this place; nor was anything representing the Potsdam sandstone detected in approaching the Highlands from Fishkill, nor elsewhere along their northern limits. Near to Peekskill, in the valley of the creek, was found a low ridge of black slate, supposed to belong to the Quebec group, and a similar slate was observed along the north side of the Highland range, not far from the gneiss. The gneiss of the Highlands presents all the aspects and characteristics of that of the Laurentian system, as seen in northern New York and in Canada.

Further examinations are necessary to determine the extension to the north-east of the Laurentian rocks of the Highlands, and also the succession of strata to the south-east of them. The recognition of the Sillery and of the Quebec group in this region are great and important facts for its geology, and not less so the identification with the Laurentian system of the gneissic district of the Highlands, to which the interesting mineral region of Orange county and the adjacent parts of New Jersey doubtless belongs. This conclusion, although opposed to the views of Mather and Rogers, who looked upon the crystalline rocks of the latter region as altered Lower Silurian strata, is in accordance with the older observations of Vanuxem and Keating, and with the more recent ones of Professor Cook, according to all of whom the gneiss and crystalline limestones of Orange County and of New Jersey underlie unconformably the Lower Silurian strata. T. S. H.

NATURAL HISTORY SOCIETY.

The first monthly meeting of the Society for the Session 1864-65 was held at its rooms on Monday evening, September 26th, Dr. Dawson, President, in the chair. A large number of donations were announced:

To the Museum.

Blackburnian warbler (*Dendroica Blackburniæ*) and the black-throated green warbler (*Dendroica virens*), shot near Montreal, and presented by Mr. W. Hunter. A large collection of English beetles, from W. M. S. D'Urban, Esq. A fine series of Canadian insects, of all orders, from Messrs. John B. Goode, C. Foley, R. J. Fowler, and Jas. Ferrier, jun. Fossils and recent shells from Prof. Dana (New-haven), Dr. Hubbard (Staten Island), E. Seymour (New York), and C. Hart. Also a number of single specimens of interest, but which we cannot particularize from want of space. The donations to the Library were also numerous.

New Members.

Prof. R. Bell was elected a corresponding, and G. W. Simpson, Esq., an ordinary member of the Society.

Proceedings.

The first paper (On *Rusophycus Grenvillensis*, Billings) was then read by Principal Dawson. This paper is printed in the present number.

Mr. Billings read a paper, "On a remarkable specimen of *Asaphus Platycephalus*." The principal point of interest in this communication was that the author claims to have discovered what the legs of trilobites were like. The structure of the upper part of these remarkable fossils, so familiar to the student of the older fossiliferous rocks, has long been known to naturalists. Dr. Buckland, in his Bridgewater treatise, has described the microscopic details of the eyes of these curious crustaceans, which organs are not unfrequently preserved in the rocks,—and has fully illustrated their complex, compound character. But until now, the only portion of the under surface known was the part containing the mouth. This organ is situated in a plate on the under surface of

the head, a considerable distance from its apex. From this circumstance Burmeister infers that "they swam in an inverted position, the belly upwards and the back downwards," as the mouth is situated so far backwards on the under side. But although even the eyes of these curious creatures are often preserved, no traces of the legs have hitherto been detected. It was supposed that they were thin and foliaceous, for it was plausibly urged that if these animals had the stout, calcareous legs of ordinary crabs, some trace of them would have been met with in the rocks.

Mr. Billings exhibited a specimen from the Trenton limestone of Ottawa, which had been in part carefully extricated from the matrix. He stated that in his opinion trilobites had a pair of thin, foliaceous legs to each segment of the thorax, or rather abdomen. The specimen of *Asaphus Platycephalus* which he passed round for examination was a specimen with eight thoracic segments, and exhibited on the under side eight semicylindrical ridges on each side of the median line, all curving outwards and forwards. These he believed to be the bases of the attachment of eight pairs of swimming feet—one pair for each segment of the thorax. Burmeister had made a sketch of what he supposed the legs of a trilobite would be like, and Mr. Billings stated that this ideal restoration was fully borne out by his specimen, except that in Burmeister's drawing the legs were directed backwards, whilst those of the actual specimen pointed forwards.

Dr. Dawson remarked that the Natural History Society might well feel proud that this important discovery in palæontology had been made by one of its own members.

Mr. Billings said that in his opinion the specimen exhibited tended to verify the views that Dr. Dawson advocated with respect to the Grenville fossil previously treated of.

Mr. D. R. McCord, B.A., next made a communication "On Canadian Ferns, their Varieties and Habitats." This paper is printed in the present number.

The Recording Secretary exhibited a collection of native ferns, collected and prepared by Miss Isabella McIntosh (of Burnside House), among which were three species of peculiar interest. The first was the "green spleenwort" (*Asplenium viride*, Hudson), a small species occurring somewhat rarely in mountainous districts in England, and in various localities in Europe. It had been previously detected in Gaspé, in the summer of 1863, by John

Bell, B.A., and this was the only station in which it was previously known to occur in Canada. The other species are the "Adder's tongue fern," (*Ophioglossum vulgatum*), of which fine specimens were collected at Melbourne, in the Eastern Townships; and the "Moonwort" (*Botrychium Lunaria*), two species well known to inhabit Europe, but now for the first time recorded as occurring in Canada.

C. Robb, Esq., exhibited a series of ferns collected in Canada West, by Mrs. Traill, the well-known authoress.

Dr. Dawson remarked that the study of the non-flowering plants of Canada was as yet but in its infancy, and that Prof. Lawson's and Mr. McCord's papers, excellent as they were, must be considered as only forming the commencement of an investigation full of interest and promise.

The second monthly meeting of the Society for the Session 1864–65 was held in its rooms on Monday evening, October 24th.

The following donations were announced:

To the Museum.

From Principal Dawson, twenty-three species of Canadian drift-fossils, and twenty-two specimens of coal-plants from Nova Scotia.

From C. Robb, Esq., *Columnaria alveolata*, a fossil-coral from the Black River limestone of Burgess, C. W. Specimen of diallage from Brompton, and examples of native and manufactured antimony from South Ham.

From Mr. W. Hunter, stuffed specimen of the night heron (*Nyctiardea Gardeni*), Baird.

From Mrs. McIntosh, a quantity of living fishes for the Aquaria.

To the Library.

From the Author, Geological Survey of Michigan, 1860, by Prof. A. Winchell.

New Members.

Hugh Fraser, Esq., was elected a life member, and the Rev. Robt. McDonald and Prof. H. Y. Hind, corresponding members of the Society.

Proceedings.

The first paper, entitled "Notes on the Geology of Eastern New York, by Prof. James Hall and Sir W. E. Logan," was read by Dr. T. Sterry Hunt. This paper is printed in the present number.

Dr. Hunt then made a verbal communication on phosphate of lime; he described its nature and composition generally, its sources in nature, and its various uses, particularly as a manure. After noting the manufacture of superphosphate of lime from bones, coprolites, and guano, he proceeded to describe the supplies of the phosphate of lime known to mineralogists as apatite, which is met with in crystalline rocks and especially in Canada; where the mineral is found abundantly in the vicinity of Perth, and also at several points along the Ottawa. The phosphate occurs both disseminated in small crystals through certain beds of crystalline limestones of the Laurentian system, and in regular veins which intersect the rocks of the same system. In these veins the mineral is sometimes found nearly pure, and at other times associated with pyroxene, large crystals of magnesian mica (which are wrought), and other silicated minerals. Not unfrequently also it is mingled with lamellar carbonate of lime, which sometimes so far predominates as to give rise to what may be called a crystalline limestone, holding grains and crystals of apatite, and can scarcely be distinguished from those stratified Laurentian limestones of the region, which also contains apatite, except by the fact that it occurs in veins, cutting the strata. Many of these are too poor in apatite to be wrought with advantage; but Dr. Hunt expressed the opinion that all the workable phosphate of the region occurs in true veins, some of which are of considerable width, and are filled with phosphate of lime almost without any foreign admixture. Dr. Hunt then proceeded to give a history of these deposits, which were first described in 1848, in the report of the Geological Survey, the officers of which had since, on repeated occasions, called attention to the value of this material, and had shown it at the great exhibitions of London and Paris. He then described the attempts now being made to work the deposits of this mineral by some New York capitalists in North Burgess, where they have forty or fifty workmen, under the direction of a skillful mining engineer.

ENTOMOLOGICAL SOCIETY OF CANADA.

The ordinary monthly meeting of the Society was held in the Council-room of the Canadian Institute on Tuesday, Dec. 8th, at 3 p.m. Nearly all themembers from Toronto and the vicinity were present. In the absence of Prof. Croft and Mr. Saunders, Dr. Morris was called to the chair, and Mr. Hubbert appointed secretary *pro tem.* The minutes of the previous meeting were read and confirmed.

Communications were received from Prof. Hincks, expressing regret at his inability to attend from indisposition; from F Grant, Esq., and R. V. Rogers, Esq., on business connected with the Society.

Rev. H. P. Hope, and Rice Lewis, Esq., Toronto, and James Wright, Esq., Vienna, C. W., were proposed as suitable persons to become members.

The following donations were acknowledged, and the thanks of the Society voted to the donors:

From Prof. Croft.

A cabinet of seven drawers.

To the Library, from the Smithsonian Institution.

Monograph of the Diptera of North America, by H. Low. Part I.

From the author, W. Saunders, Esq., London, C. W.

(1.) Monograph of the Arctiades of Canada. 20 copies.
(2.) Description of ten new species of Arctia.
(3.) "On some hitherto undescribed Lepidopterous Larvæ."

From A. S. Packard, Esq., Jun., Cambridge, Mass., through Principal Dawson.

Photographs of the following undescribed bombyces:

Crambida pallida, Callimorpha vesta, Callochlora chlorata, Cyrtosia albipunctata, male and female, Entrutricudes testacea, Cyrtosia geminata, Cilodasys cinereafrons, Laphodonta ferruginea, Gluphisia trilineata, male and female, Platyarma furcilla, Cilodasys biguttata, Edaplenyx bilineata.

From James Hubbert, Esq., B.A.

Popular Entomology, by Maria E. Catlow.
British Butterflies, by W. S. Coleman.

To the Cabinet, from Prof. Croft.

48 specimens, including 27 species of Chinese Lepidoptera.
164 specimens, including 61 species of Coleoptera.

From B. R. Morris, Esq., B.A., M.D.

47 specimens, including 16 species of Coleoptera.

From J. H. Sangster, Esq., M.A.

23	specimens,	including	17	species of	Coleoptera.
6	"	"	5	"	" Lepidoptera.
11	"	"	10	"	" Diptera.
10	"	"	10	"	" Hymenoptera.
5	"	"	4	"	" Neuroptera.
4	"	"	4	"	" Orthoptera.

From B. Billings, Esq., Ottawa.

236	specimens,	including	132	species of	Coleoptera.
21	"	"	19	"	" Lepidoptera.
6	"	"	5	"	" Diptera.
7	"	"	5	"	" Orthoptera.
3	"	"	2	"	" Strepsiptera.
3	"	"	3	"	" Hemiptera.

From James Hubbert, Esq., B.A.

251	specimens,	including	176	species of	Coleoptera.
63	"	"	25	"	" Lepidoptera.
44	"	"	40	"	" Diptera.
38	"	"	27	"	" Hymenoptera.
12	"	"	10	"	" Orthoptera.
12	"	"	8	"	" Neuroptera.
15	"	"	10	"	" Hemiptera.

From Thomas Reynolds, Esq., Montreal.

13	specimens,	including	8	species of	Coleoptera.
159	"	"	53	"	" Lepidoptera.
1	"	"	1	"	" Diptera.
9	"	"	6	"	" Hymenoptera.
2	"	"	1	"	" Hemiptera.

From W. Saunders, Esq., London.

345	specimens,	including	121	species of	Coleoptera.
111	"	"	37	"	" Lepidoptera.
8	"	"	5	"	" Neuroptera.
1	"	"	1	"	" Diptera.
4	"	"	1	"	" Strepsiptera.

A communication was read from Mr. Saunders regarding the practicability of publishing a catalogue of the known Canadian species of each order of insects. After considerable discussion as to the best form, etc., it was moved and seconded, That the Society take immediate steps to prepare and publish catalogues of the Coleoptera and Lepidoptera; to be followed by similar catalogues of the other orders as soon as possible; and that Mr. Saunders, Prof. Croft, and Mr. Billings be a committee on Coleoptera; and Prof. Hincks, Mr. Saunders, and Dr. Morris on

Lepidoptera. Carried. The Committees are very anxious to secure the co-operation of all persons having either named collections or lists of species. Any information which would aid in bringing out full and accurate catalogues should be communicated without delay to Mr. Saunders or Prof. Hincks. Moved and seconded that a supply of entomological pins, and sheet cork for lining cabinets, be procured and kept on hand, to be furnished to members at the lowest cost prices. Carried.

It is intended ultimately to keep all the apparatus required in capturing and preserving insects.

Moved and seconded that the Rev. Chas. J. Bethune, B.A., be requested to use his influence to advance the interests of the Society among entomologists in Britain. Carried.

A verbal communication was made by Dr. Morris on insects captured in the vicinity of Orillia during the summer of 1863.

Among the interesting specimens exhibited by Dr. Morris were several examples of *Colias edusaco*, seldom met with in Canada, only two or three individuals having been taken as yet. The Dr. remarked that this insect seems to differ from the *C. edusa* of British naturalists in its habits of flight, etc., which seem to indicate either a new species or very wide variations.

Both sexes of *Lerias lesa*, also very rare in Canada, had been captured. A species of *Arrhenodes*, taken by Mr. F. Grant of Orillia, was also exhibited. The general appearance of the insect closely resembled that of *A. septentrionis*, of which it is probably a variety. The form of the rostrum, however, is so peculiar as to lead the Dr. to think that possibly there may be two species with us.

Papers presented by Mr. Hubbert:

(1). "Notes on Insects captured near Kingston, 1863."

(2). "What the Insects do in January."

The meeting then adjourned.

ON THE LARVÆ OF ATTACUS POLYPHEMUS.

BY WILLIAM COUPER, QUEBEC.

On the 14th of August 1863, I found two caterpillars of *A. polyphemus* feeding on sweet-briar in the vicinity of Montmorenci river, near Quebec. They were carefully carried to my home, and the above food-plant supplied daily, excepting that the

thorns were picked off the branches before the larvæ were attached thereon. The lepidopterist will no doubt understand my astonishment to find the large, soft, thin-skinned, and hairless larva of *A. polyphemus* feeding on the sweet-briar, a plant said to be introduced into Canada. Harris gives three food-plants, *i. e.*, the oak, elm, and lime trees. Formerly I found it feeding on a species of maple at Toronto, and now in the Lower Provinces we find it on the thorny briar. How they manage to turn and creep from one branch to another without coming in contact with the numerous thorns, I am unable to explain. They continued to feed on the supplied food up to the 28th of August, on which day they ceased to feed, and prepared to spin. The caterpillar that produced the male first ceased feeding; it was also the first to issue from its cocoon, although both were subject to an equal temperature. A short time previous to spinning, both caterpillars ejected the contents of the viscera, consisting of about a teaspoonful of a dark green fluid, and immediately afterwards they began to form their cocoons. I notice this singular caterpillar *ejectamentum*, as I think it has been hitherto overlooked, and it would be advancing our knowledge in entomological science to have this fluid analyzed. The caterpillar that produced the male had the dorsal tubercles much shorter than the one that issued from the other cocoon; they were tipped with bright yellow, with a slight golden reflection. The caterpillar of the second cocoon, or the one producing the supposed female, had the lateral and dorsal tubercles bright orange red, mingled with golden, the tubercles were more robust and longer than the one which produced the male. Unfortunately, during my absence from home, the moth from the second cocoon escaped through the window, and I am therefore unable to prove the imago sex with the larvæ. But from external characters alone, I rest satisfied that the future investigator will find that the richest colored caterpillar forms the cradle of the female. I trust my short investigation may lead others to study the metamorphosis of this genus of moths. No doubt if a thorough search is also made for the larvæ of *A. luna* in the Lower Provinces, it will be found feeding on a plant different from its western food, and probably hitherto unknown to be used as such by this beautiful moth.

MISCELLANEOUS.

CALLUNA VULGARIS.—Professor Lawson, of Dalhousie College, Halifax, has sent to one of the editors a specimen of this plant, the common heather of Scotland, from St. Ann's Bay, Cape Breton. This confirms an old report, referred to in vol. vii of this journal, p. 343, of its occurrence in that island; and affords another certainly ascertained American locality, in addition to those previously known in Massachusetts and Newfoundland. It should be satisfactory to the Scotsman in British America to know that there is at least one spot in his adopted country where he can plant his foot on his native heather. The apparent rarity of the plant in America is however no less curious than its extension to this country; and it remains as a question for future botanists to settle whether it is now being introduced to the new world or gradually dying out from it.

THE GEOLOGICAL MAGAZINE.—The *Geologist*, of London, has been merged in a new periodical, to be edited by Prof. T. R. Jones and Henry Woodward. Its prospectus says:

The rapid progress of geology in all its branches, and especially the wide-spread interest imparted to this science by the recent careful investigation of some of the more modern strata, have largely increased the number of those who study geology, either professionally or as amateurs. The frequent discoveries, also, which result from the exertions of practical geologists, both at home and abroad, appear to indicate the necessity of a monthly periodical, not only for the publication of original papers on geology and kindred subjects, as well as of translations of important foreign memoirs, but also as the means of communication between geologists and palæontologists in England and other countries.

The valuable Journal of the Geological Society fulfils some of these requirements; but being published only quarterly, and necessarily restricted almost entirely to the proceedings of that Society, it cannot serve all the purposes proposed by the conductors of *The Geological Magazine.*

In Germany the *Neues Jahrbuch* has fulfilled the requirements of the geological public for the last thirty years with unvarying success; and the editor and publishers of the Monthly *Geologist* have during six years endeavored to meet them in England. The latter work is now merged in *The Geological Magazine.*

The publishers and editors of *The Geological Magazine* have not hastily undertaken the task which lies before them; but, having consulted the most eminent geologists and palæontologists of the day (amongst whom may be mentioned Sir Philip Egerton, Sir Roderick Murchison, Sir Charles Lyell, G. Poulett Scrope, Esq., Professors Sedgwick, Phillips, Owen, Ramsay, Morris, and Huxley, and Dr. Falconer), they are not unaware of what will be expected of them; and they have received such assurances of support and encouragement, as well as promises of original contributions, that they confidently trust their efforts will meet with success.

Another well-known scientific magazine, the *Edinburgh New Philosophical Journal*, has been merged in the new *Quarterly Journal of Science*, published in London.

MEETING OF BRITISH ASSOCIATION.

LECTURE BY DR. LIVINGSTONE.

On the evening of September 20, the theatre was crowded by members of the Association, anxious to hear the lecture announced by Dr. Livingstone on his travels and labors in Africa.

Sir R. Murchison stated that the assistant-general-secretary, Mr. Griffiths, had made such excellent arrangements that, while Dr. Livingstone is lecturing there, his lecture would be read in another place to many hundreds of the Association who could not find room in the theatre; and that when that assembly was adjourned, his friend would move to the other room, and there thank that assembly which was met to do him honor also.

Dr. Livingstone then delivered the following lecture:—In order that the remarks I have to offer may be clearly understood, it is necessary to call to mind some things which took place previous to the Zambesi Expedition being sent out; and most of you are, no doubt, aware, that previous to the discovery of Lake Ngami and the well-watered country in which the Makololo dwell, the idea prevailed that a large part of the interior of Africa was composed of vast sandy deserts into which rivers ran and were lost. In a journey from sea to sea across the continent, somewhat north of the lake first discovered, it was found that there, too, the country was well watered. Large tracts of fertile soil were covered with forest, and occupied by a considerable population. We had, then, the

form of the continent revealed to be an elevated plateau, somewhat depressed in the centre, with fissures at the sides, by which the rivers escaped to the sea: and this great fact in physical geography can never be referred to without mentioning the remarkable hypothesis by which the distinguished President of the Royal Geographical Society (Sir R. Murchison) clearly delineated it before it was verified by actual observation of the altitudes of the country and courses of the rivers. It was published in one of his famous anniversary addresses; and he has been equally happy in his last address in pointing out the ancient geological condition of the interior of this continent as probably the oldest in the world—a fact we, who were on the spot, could but dimly guess. But he seems to have the faculty of collecting facts from every source, and concentrating them into a focus in a way no one else can accomplish. (Cheers.) We understand it only after he has made it all plain in his study at home. Then followed the famous travels of Dr. Barth and Francis Galton; the most interesting discoveries of Lake Zangnyika and Victoria Nyawya, of Captain Burton, and Captain Speke, whose sad loss we all now so deeply deplore, and, again, of Lakes Shirwe and Nyassa; the discoveries of Van der Decken and several others; but, last of all, the grand discovery of the main source of the Nile, which every Englishman must feel proud to know was accomplished by our countrymen Speke and Grant. In all this exploration the main object in view has not been merely to discover objects of nine days' wonder—to gaze, and be gazed at by barbarians—I would not give a fig to discover even a tribe with tails!—but, in proceeding to the west coast, to find a path to the sea, whereby lawful commerce might be introduced to aid missionary efforts. I was very much struck by observing that the decided influence of that which is known as Lord Palmerston's policy existed several hundreds of miles from the ocean. I found piracy had been abolished, and that the slave-trade had been so far suppressed as to be spoken of as a thing of the past; that lawful commerce had increased from 20,000*l.* in ivory and gold-dust to between 2,000,000*l.* and 3,000,000*l.*, 1,000,000*l.* of which was in palm-oil to our own country; that over twenty missions had been established, with schools in which 12,000 pupils were taught; that life and property were secure on the coast, and comparative peace established in large portions of the interior; and all this was at a time when, from reading the speeches of well-informed gentlemen at home, I had come to the conclusion that our cruisers had done

nothing but aggravate the evils of the slave-trade. Well, not finding what I wished by going to the west coast, I came down the Zambesi to the east coast, and there I found the country sealed up. The same efforts had been made by our cruisers here as on the west coast, but, in consequence of foreigners being debarred from entering the country, neither traders nor missionaries had established themselves. The trade was only in a little ivory, and gold-dust and slaves; just as it was on the west coast before Lord Palmerston's policy came into operation. It seemed to me, therefore, that as the Portuguese Government professed itself willing to aid in opening the country, and we had a large river, Zambesi, which, being full when I first descended, it seemed a famous inlet to the higher lands and interior generally; I knew the natives to be almost all fond of trading, and, when away from the influence of the slave-trade, friendly and mild, the soil fertile, and cotton and other products widely cultivated. It therefore appeared to me that if I could open this region to lawful commerce I should supplement the efforts of our cruisers, in the same way as has been done by traders and missionaries on the west coast, and perform a good service to Africa and to England. To accomplish this was the main object of the Zambesi Expedition, and in speaking of what was done, it is to be understood that Dr. Kirk, Mr. Livingstone, and others composed it; and when I speak in the plural number I mean them, and wish to bear testimony to the zeal and untiring energy with which my companions worked. They were never daunted by difficulties, nor dangers, nor hard fare, and were their services required in any other capacity might be relied on to perform their duty. The first discovery we made was a navigable entrance to the Zambesi, about a degree west of the Quillimane River, which had always been represented as the mouth of the Zambesi, in order, as some maintained, that the men-of-war might be induced to watch the false mouth while slaves were quietly shipped from the real mouth. This mistake has lately been propagated in a map by the Colonial Minister of Portugal. On ascending the Zambesi we found that the Portuguese authorities, to whom their Government had kindly commended us, had nearly all fled down to the sea-coast, and the country was in the hands of the natives, many of whom, by their brands, we saw had been slaves. As they were all quite friendly with us, we proceeded to our work, and ascended the river in a little steamer which, having been made of steel plates, a material never before tried, and with an engine and boiler, the sweepings of some shop,

very soon failed us. Indeed, the common canoes of the country passed us with ease, and the people in them looked back, wondering what this puffing, asthmatic thing could mean. The crocodiles thought it was a land-animal swimming, and rushed at it in hopes of having a feast. The river for the first 300 miles is from half a mile to three miles wide. During half the year the water is abundant and deep: during the other half, or the dry season, it is very shallow; but with properly constructed vessels much might be made of it during the whole of ordinary years. We proceeded as soon as we could to the rapids above Zette, our intention having originally been to go up as far as the Great Victoria Falls, and do what we could with the Makololo, but our steamer could not stem a four-knot current. We then turned off to an affluent of the Zambesi, which flows into it about 100 miles from the sea; it is called the Shire, and, as far as we know, was never explored by any European before. It flows in a valley about 200 miles long and twenty broad. Ranges of hills shut in the landscape on both sides, while the river itself winds excessively among marshes; in one of these we counted 800 elephants, all in sight at one time. The population was very large; crowds of natives, armed with bows and poisoned arrows, lined the banks, and seemed disposed to resent any injury that might be inflicted. But by care and civility we gave them no occasion for commencing hostilities, though they were once just on the point of discharging their arrows. On a second visit they were more friendly, and the women and children appeared. We had so far gained their confidence that we left the steamer at Murchison's Cataracts; and Dr. Kirk and I, proceeding on foot to the N.N.E., discovered Lake Shirwe. This lake is not large; it is said to have no outlet, and this is probably the case, for its water is brackish; it abounds in fish, hippopotami, and leeches. The scenery around is very beautiful, the mountains on the east rising to a height of 8,000 or 9,000 feet. We were now among Manganja, a people who had not been visited by Europeans, and as I am often asked what sort of folk these savages are, I may answer they were as low as any we ever met, except Bushmen, yet they all cultivate the soil for their sustenance. They raise large quantities of maize, or Indian corn, and another grain, which grows in a stalk ten or twelve feet high, with grain very much like the hemp-seed given to canaries, and called by the Arabs *dura* (*Hælcus georghum*); another kind of grain (tennisetum); several kinds of beans, pumpkins, and melons; cucumbers, from the seeds of

which a fine oil is extracted; cassava, from which our tapioca is made; ground-nuts, which yield an oil for cooking; castor-oil, with which they anoint their bodies; and tobacco and Indian hemp for smoking. The labor in the fields seemed to be performed by the whole family,—men, women, and children being generally seen in the fields together. Each family had a patch of cotton, just as our forefathers had each a patch of lint; and this cotton was spun and woven by the men, while the women malted and ground the corn, and made the beer. Near many of the villages furnaces were erected for smelting iron from the ore, and excellent hoes were made very cheap. All were very eager traders, and very few were hunters; so they can scarcely be called savages, though, without a doubt, they were degraded enough. Their life has always appeared to me to be one of fear. They may be attacked by other tribes, and sold into slavery; and the idea this brings is, that they will be taken away, fattened, and eaten by the whites. The slave-trader calls them beasts and savages, and they believe the slave-traders to be cannibals. They also live in fear of witchcraft; and suspected persons are frequently compelled to drink the ordeal water, which is just about as sensible a means of detecting witches as our former mode of ducking in a pond. If the suspected person vomits, she is innocent; if not, guilty: and yet we laugh heartily at our forefathers believing that the woman who sank in the pond was innocent, and guilty if she swam,—just as monomaniacs do with their illusions. Cultivating large tracts of land for grain, a favorite way of using the produce is to convert it into beer. It is not very intoxicating, but when they consume large quantities they do become a little elevated. When a family brews a large quantity, the friends and neighbors are invited to drink, and bring their hoes with them. They let off the excitement in merrily hoeing their friend's field. At other times they consume large quantities for the same object as our regular topers at home. We entered one village, and found the people all tipsy together. On seeing us the men tried to induce the women to run away; but the ladies, too, were, as we mildly put it, "a little overcome," and laughed at the idea of their running. The village doctor arranged matters by bringing a large pot of the liquid, with the intention, apparently, of reducing us to the general level. Well, the people generally, if we except the coast tribes, are very much like these, without the drunkenness. Wherever tzetze exists the people possess no cattle, as this insect proves fatal to all domestic animals,

except the goat, man, and donkey. Its bite does no harm to man nor to the donkey, though one donkey we took through a tzetze district did die, probably from over-fatigue. We made no discovery as to the nature of the curious poison injected by the insect, nor could we find out where it laid its eggs. Where the slave-trade is unknown the cattle are the only cause of war. The Makololo will travel a month for the sake of lifting cattle; this is not considered stealing; and when the question is put, "Why should you lift what does not belong to you?" they return the Scotch answer, "Why should these Makalaka (or black fellows) possess cattle if they can't defend them?" Having secured the good-will of all the people below and adjacent to Murchison's Cataracts, we next proceeded further north, and discovered the Shire flowing in a broad, gentle stream out to Lake Nyassa, about sixty miles above the cataracts. The country on each side of the river and lake rises up in what, from below, seem ranges of mountains, but when they have been ascended they turn out to be elevated plateaux, cool and well watered with streams. To show the difference of temperature, we were drinking the waters of the Shire at eighty-four degrees, and by one day's march up the ascent, of between 3,000 and 4,000 feet, we had it at sixty-five degrees, or nineteen degrees lower. It felt as if iced. We had no trouble with the people. No dues were levied, nor fines demanded, though the Manganja were quite independent in their bearing towards us, and strikingly different from what they afterwards became. Our operations were confined chiefly to gaining the friendship of the different tribes, and imparting what information we could with a view to induce them to cultivate cotton for exportation. It has already been mentioned that each family had its own cotton-patch; some of these were of considerable extent; one field, close to Zedzan Cataract, I lately found to be 630 paces on one side, and the cotton was of excellent quality, not requiring replanting oftener than once in three years, and no fear of injury by frost. After careful examination, I have no hesitation in re-asserting that we have there one of the finest cotton-fields in the world. On remonstrating with the chiefs against selling their people into slavery, they justified themselves on the plea that none were sold except criminals. The crimes may not always be very great, but I conjecture, from the the extreme ugliness of many slaves, that they are the degraded criminal classes; and it is not fair to take the typical negro from among them any more than it would be to place "Bill Sykes" or some of *Punch's*

garrotters as the typical John Bull. For years I had been looking out for the typical negro, and never felt satisfied that I had got him, for many of them are the pictures of the old Assyrians; others, barring color, which we soon forget, closely resemble acquaintances at home. But Mr. Winwood Read, in his work, "Savage Africa," seems to have lighted right on the head of the idea, in saying that no typical negro is seen in the portraits and monuments of the ancient Egyptians. When we had succeeded in gaining the goodwill of the people which crowded the Shire valley, the mission under the late Bishop Mackenzie came into the country. Dr. Kirk had performed a journey from the Murchison Cataracts across to Zette, a Portuguese village upon the Zambesi. Slave-hunters then were sent along Dr. Kirk's route by the sanction of the present Government, calling themselves "my children." The scamps! They joined themselves to another tribe called Ajawa, then in the act of migrating from the south-east, and who had been accustomed to take slaves annually down to Quillimane, and other settlements on the coast. Furnishing the Ajawa with arms and ammunition, they found it easy to drive those who were armed only with bows and arrows before them. When Dr. Kirk and Mr. Charles Livingstone, and I went up to show Bishop Mackenzie on to the highlands, we met a party of these Portuguese slaves coming with eighty-four captives bound and led towards Zette. The head of the party we knew perfectly, having had him in our employment in Zette. No force was employed, for even the slaves of the Governor knew that they were doing wrong, and fled, leaving the whole of the captives on our hands. Bishop Mackenzie received them gladly, and in a fertile country, with land free, in the course of a year or two, might, by training some sixty boys to habits of industry, have rendered his mission independent as far as native support was concerned. Having been engaged in the formation of two missions in another part of the country, and having been familiar with the history of several, I never knew a mission undertaken under more favorable auspices. This would be the opinion of all who have commenced similar enterprises in other parts, and it was that of the good bishop himself. He was so thoroughly unselfish, and of such a genial disposition, that he soon gained the confidence of people; and this is the first great step to success. The best way of treating these degraded people must always be very much that which is pursued in ragged schools. Their bodily wants must be attended to as the basis of all efforts at their ele-

vation. The slave-trade is the gigantic evil which meets us at every step in the country. We cannot move through any part without meeting captured men and women, bound, and sometimes gagged; so no good can be done if this crying evil is not grappled with. The good bishop had some 200 people entirely at his disposal, and would soon have presented to the country an example of a free community, supported by its own industry, where fair dealing could be met, which undoubtedly would have created immense influence; for wherever the English name is known it is associated with freedom and fair play. Some seem to take a pleasure in running down their fellow-countrymen; but the longer I live, I like them the better. They carry with them some sense of law and justice, and a spirit of kindliness; and were I in a difficulty, I should prefer going to an Englishman rather than to any other for aid. And as for Englishwomen, they do, undoubtedly, make the best wives, mothers, sisters, and daughters in the world. It is this conviction that makes me, in my desire to see slavery abolished, and human happiness promoted, ardently wish to have some of our countrywomen transplanted to a region where they would both give and receive benefit, where every decent Christian Englishman, whether churchman or dissenter, learned or unlearned, liberal or bigoted, would certainly become a blessing by introducing a better system than that which has prevailed for ages. We conducted Bishop Mackenize and party up to the highlands, and after spending three or four days with them, returned, and never had any more connection with the conduct of that mission. We carried a boat past Murchison's Cataracts. By these the river descends at different leaps of great beauty, 1,200 feet in a distance of about 40 miles. Above that we have sixty miles of fine deep rivers, flowing placidly out of Lake Nyassa. As we sailed into this fine freshwater lake, we were naturally anxious to know its depth—ten, twelve, twenty, thirty fathoms—then no bottom with all our line; and John Neill, our sailor, at last pronounced it fit for the Great Eastern to sail in. We touched the bottom in a bay with a line of 100 fathoms, and a mile out could find no bottom at 116 fathoms. It contains plenty of fish, and great numbers of natives daily engage in catching them with nets, hooks, spears, torches, and poison. The water remains at 72°, and the crocodiles having plenty of fish to eat rarely attack men. It is from fifty to sixty miles broad, and we saw at least 225 miles of its length. As seen from the lake, it seems surrounded by moun-

tains, and from these furious storms come suddenly down and raise high seas, which are dangerous for a boat, but the native canoes are formed so as to go easily along the surface. The apparent mountains on the west were ascended last year, and found to be only the edges of a great plateau, 3,000 feet above the sea. This is cool, well watered, and well peopled with the Manganja and the Maori, some of whom possess cattle; and I have no doubt but that, the first hardships over, and properly housed and fed, Europeans would enjoy life and comfort. This part of Africa has exactly the same form as Western India at Bombay, only this is a little higher and cooler. Well, having now a fair way into the highlands by means of the Zambesi and Shire, and a navigable course of river and lake, of two miles across, which all the slaves from the Red Sea and the Persian Gulf, as well as some for Cuba took, and nearly all the inhabitants of this densely-peopled country actually knowing how to cultivate cotton, it seemed likely that their strong propensity to trade might be easily turned to the advantage of our own country as well as theirs. And here I beg to remark that on my first journey, my attention not having then been turned to the subject, I noticed only a few cases of its cultivation, but on this I saw much more than I had previously any idea of. The cotton is short in the staple, strong, and like wool in the hand—as good as upland American. A second variety has been introduced, as is seen in the name, being foreign cotton, and a third of very superior quality, very long in the fibre, though usually believed to belong to South America, was found right in the middle of the continent in the country of the Makololo. A tree of it was eight inches in diameter, or like an ordinary apple-tree. And all these require planting not oftener than once in three years. There is no danger of frosts, either, to injure the crops. No sooner, however, had we begun our labors among the Manganja than the African Portuguese, by instigating the Ajawa, with arms and ammunition, to be paid for in slaves, produced the utmost confusion. Village after village was attacked and burnt; for the Manganja, armed only with bows and arrows, could not stand before firearms. The bowman's way of fighting is to be in ambush, and to shoot his arrows unawares, while those with guns, making a great noise, cause the bowmen to run away. The women and children become captives. This process of slave-hunting went on for some months, and then a panic seized the Manganja nation. All fled down to the river, only anxious to get that between them and their enemies; but they had left all

their food behind them, and starvation of thousands ensued. The Shire valley, where thousands lived, at our first visit was converted literally into a valley of dry bones. One cannot now walk a mile without seeing a human skeleton; open a hut in the now deserted villages, and there lie the unburied skeletons. In some I opened, there were two skeletons; and a little one, rolled up in a mat, between them. I have always hated putting the blame of being baffled upon any one else, from a conviction that a man ought to succeed in all feasible projects, in spite of everybody; and, moreover, I wish not to be understood as casting a slur upon the Portuguese in Europe, for the Viscount Lavaidio, the Viscount de la Bandeira, and others, are as anxious to see the abolition of the slave-trade as could be desired; but the evil is done by the assertion in Europe of dominion in Africa, when it is quite well known that the Portuguese in Africa were only a few half-castes, the children of converts and black women, who have actually to pay tribute to the pure natives. Were they of the smallest benefit to Portugal? If any one ever made a fortune and went home to spend it in Lisbon; or if any pleasure whatever could be derived by the Portuguese government from spending £5000 annually on needy governors, who all connive at the slave-trade, the thing could be understood. But Portugal gains nothing but a shocking bad name, as the first that began the slave-trade, and the last to end it. To us it is a serious matter to see Lord Palmerston's policy, which has been so eminently successful on the west, so largely neutralised on the east coast. A great nation like ours cannot get rid of the obligations to other members of the great community of nations. The police of the sea must be maintained; and should we send no more cruisers to suppress the slave-trade, we would soon be obliged to send them to suppress piracy, for no traffic engenders lawlessness as does this odious trade. The plan I propose required a steamer on Lake Nyassa to take up the ivory-trade, as it is by the aid of that trade that the traffic in slaves is carried on. The Government sent out a steamer, which, though an excellent one, was too deep for the Shire. Another steamer was then built at my own expense; this was all that could be desired, made to unscrew into twenty-four pieces, and the Lady Nyassa, or Lady of the Lake, was actually unscrewed and ready for conveyance to the scene of the missionary work, but that must be done by younger men, specially educated for it—men willing to rough it, and yet hold quietly and patiently on. When I became Consul, it

was with the confident hope that I should carry out this work, and I do not mean to give it up. If being baffled had ever made me lose heart, I should never have been here in the position which by your kindness I now occupy. I intend to make another attempt, but this time to the north of the Portuguese territory; and I feel greatly encouraged by the interest you show, as it cannot be for the person, but from your sympathy for the cause of human liberty; for it startles us to see a great nation of our own blood despising the African's claims to humanity, and drifting helplessly into a war about him, and then drifting quite as helplessly into abolition and slavery principles; then, leading the Africans to fight. No mighty event like this terrible war ever took place without teaching terrible lessons. One of these may be that, though "on the side of the oppressor there is power, there be higher than they." With respect to the African, neither drink, nor disease, nor slavery can root him out of the world. I never had any idea of the prodigious destruction of human life that takes place subsequently to the slave-hunting, till I saw it; and as this has gone on for centuries, it gives a wonderful idea of the vitality of the nation.

EXTRACTS FROM THE ADDRESS OF THE PRESIDENT,

SIR CHARLES LYELL, D.C.L., F.R.S.

Gentlemen of the British Association,—The place where we have been invited this year to hold our thirty-fourth meeting is one of no ordinary interest to the cultivators of physical science. It might have been selected by my fellow-laborers in geology as a central point of observation, from which, by short excursions to the east and west, they might examine those rocks which constitute, on the one side, the more modern, and on other the more ancient records of the past, while around them and at their feet lie monuments of the middle period of the earth's history. But there are other sites in England which might successfully compete with Bath as good surveying stations for the geologist. What renders Bath a peculiar point of attraction to the student of natural phenomena is its thermal and mineral waters, to the sanatory powers of which the city has owed its origin and celebrity. The great volume and high temperature of these waters render them not only unique in our island, but perhaps without a parallel in the rest of Europe, when we duly take into account their distance from the nearest region of violent earthquakes or of active or extinct volcanoes. The

spot where they issue, as we learn from the researches of the historian and antiquary, was lonely and desert when the Romans first landed in this island, but in a few years it was converted into one of the chief cities of the newly conquered province. On the site of the hot-springs was a large morass from which clouds of white vapor rose into the air; and there first was the spacious bath-room built, in a highly ornamental style of architecture, and decorated with columns, pilasters, and tessellated pavements. By its side was erected a splendid temple dedicated to Minerva, of which some statues and altars with their inscriptions, and ornate pillars, are still to be seen in the Museum of this place. To these edifices the quarters of the garrison, and in the course of time the dwellings of new settlers, were added; and they were all encircled by a massive wall, the solid foundations of which still remain.

A dense mass of soil and rubbish, from 10 to 20 feet thick, now separates the level on which the present city stands from the level of the ancient Aquæ Solis of the Romans. Digging through this mass of heterogeneous materials, coins and coffins of the Saxon period have been found; and lower down, beginning at the depth of from 12 to 15 feet from the surface, coins have been disinterred of Imperial Rome, bearing dates from the reign of Claudius to that of Maximus in the fifth century. Beneath the whole are occasionally seen tessellated pavements still retaining their bright colors; one of which, on the site of the Mineral-water Hospital, is still carefully preserved, affording us an opportunity of gauging the difference of level of ancient and modern Bath.

On the slopes and summits of the picturesque hills in the neighborhood rose many a Roman villa, to trace the boundaries of which and to bring to light the treasures of art concealed in them, are tasks which have of late years amply rewarded the researches of Mr. Scarth and other learned antiquaries. No wonder that on this favored spot we should meet with so many memorials of former greatness, when we reflect on the length of time during which the imperial troops and rich colonsits of a highly civilized people sojourned here; having held undisturbed possession of the country for as many years as have elapsed from the first discovery of America to our own times.

One of our former Presidents, Dr. Daubeny, has remarked that nearly all the most celebrated hot-springs of Europe, such as those of Aix-la-Chapelle, Baden-Baden, Naples, Auvergne, and the Pyrenees, have not declined in temperature since the days of the Ro-

mans; for many of them still retain as great a heat as is tolerable to the human body, and yet when employed by the ancients they do not seem to have required to be first cooled down by artificial means. This uniformity of temperature, maintained in some places for more than 2000 years, together with the constancy in the volume of the water, which never varies with the seasons, as in ordinary springs, the identity also of the mineral ingredients which, century after century, are held by each spring in solution, are striking facts, and they tempt us irresistibly to speculate on the deep subterranean sources both of the heat and mineral matter. How long has this uniformity prevailed? Are the springs really ancient in reference to the earth's history, or, like the course of the present rivers and the actual shape of our hills and valleys, are they only of high antiquity when contrasted with the brief space of human annals? May they not be like Vesuvius and Etna, which, although they have been adding to their flanks, in the course of the last 2000 years, many a stream of lava and shower of ashes, were still mountains very much the same as they now are in height and dimensions from the earliest times to which we can trace back their existence? Yet although their foundations are tens of thousands of years old, they were laid at an era when the Mediterranean was already inhabited by the same species of marine shells as those with which it is now peopled; so that these volcanoes must be regarded as things of yesterday in the geological calendar.

Notwithstanding the general persistency in character of mineral waters and hot-springs ever since they were first known to us, we find on inquiry that some few of them, even in historical times, have been subject to great changes. These have happened during earthquakes which have been violent enough to disturb the subterranean drainage and alter the shape of the fissures up which the waters ascend. Thus during the great earthquake at Lisbon in 1755, the temperature of the spring called La Source de la Reine at Bagnères de Luchon, in the Pyrenees, was suddenly raised as much as 75° F., or changed from a cold spring to one of 122° F., a heat which it has since retained. It is also recorded that the hot-springs at Bagnères de Bigorre, in the same mountain-chain, became suddenly cold during a great earthquake which, in 1660, threw down several houses in that town.

It has been ascertained that the hot-springs of the Pyrenees, the Alps, and many other regions are situated in lines along which the rocks have been rent, and usually where they have been displaced

or "faulted." Similar dislocations in the solid crust of the earth are generally supposed to have determined the spots where active and extinct volcanoes have burst forth; for several of these often affect a linear arrangement, their position seeming to have been determined by great lines of fissure. Another connecting link between the volcano and the hot-spring is recognizable in the great abundance of hot-springs in regions where volcanic eruptions still occur from time to time. It is also in the same districts that the waters occasionally attain the boiling-temperature, while some of the associated stufas emit steam considerably above the boiling-point. But in proportion as we recede from the great centres of igneous activity, we find the thermal waters decreasing in frequency and in their average heat, while at the same time they are most conspicuous in those territories where, as in Central France or the Eifel in Germany, there are cones and craters still so perfect in their form, and streams of lava bearing such a relation to the depth and shape of the existing valleys, as to indicate that the internal fires have become dormant in comparatively recent t mes. If there be exceptions to this rule, it is where hot-springs are met with in parts of the Alps and Pyrenees which have been violently convulsed by modern earthquakes.

To pursue still further our comparison between the hot-spring and the volcano, we may regard the water of the spring as representing those vast clouds of aqueous vapor which are copiously evolved for days, sometimes for weeks, in succession from craters during an eruption. But we shall perhaps be asked whether, when we contrast the work done by the two agents in question, there is not a marked failure of analogy in one respect—namely a want, in the case of the hot-spring, of power to raise from great depths in the earth voluminous masses of solid matter corresponding to the heaps of scoriæ and streams of lava which the volcano pours out on the surface. To one who urges such an objection it may be said that the quantity of solid as well as gaseous matter transferred by springs from the interior of the earth to its surface is far more considerable than is commonly imagined. The thermal waters of Bath are far from being conspicuous among European hot-springs for the quantity of mineral matter contained in them in proportion to the water which acts as a solvent; yet Professor Ramsay has calculated that if the sulphates of lime and of soda, and the chlorides of sodium and magnesium, and the other mineral ingredients which they contain, were solidified, they would form in one year a square column

nine feet in diameter, and no less than 140 feet in height. All this matter is now quietly conveyed by a stream of limpid water, in an invisible form, to the Avon, and by the Avon to the sea; but if, instead of being thus removed, it were deposited around the orifice of eruption, like the siliceous layers which encrust the circular basin of an Icelandic geyser, we should soon see a considerable cone built up, with a crater in the middle; and if the action of the spring were intermittent, so that ten or twenty years should elapse between the periods when solid matter was emitted, or (say) an interval of three centuries, as in the case of Vesuvius between 1306 and 1631, the discharge would be on so grand a scale as to afford no mean object of comparison with the intermittent outpourings of a volcano.

Dr. Daubeny, after devoting a month to the analysis of the Bath waters in 1833, ascertained that the daily evolution of nitrogen gas amounted to no less than 250 cubic feet in volume. This gas, he remarks, is not only characteristic of hot-springs, but is largely disengaged from volcanic craters during eruptions. In both cases he suggests that the nitrogen may be derived from atmospheric air, which is always dissolved in rain-water, and which, when this water penetrates the earth's crust, must be carried down to great depths, so as to reach the heated interior. When there, it may be subjected to deoxidating processes, so that the nitrogen, being left in a free state, may be driven upwards by the expansive force of heat and steam, or by hydrostatic pressure. This theory has been very generally adopted, as best accounting for the constant disengagement of large bodies of nitrogen, even where the rocks through which the spring rises are crystalline and unfossiliferous. It will, however, of course be admitted, as Professor Bischoff has pointed out, that in some places organic matter has supplied a large part of the nitrogen evolved.

Carbonic-acid gas is another of the volatilized substances discharged by the Bath waters. Dr. Gustav Bischoff, in the new edition of his valuable work on chemical and physical geology, when speaking of the exhalations of this gas, remarks that they are of universal occurrence, and that they orginate at great depths, becoming more abundant the deeper we penetrate. He also observes that, when the silicates which enter so largely into the composition of the oldest rocks are percolated by this gas, they must be continually decomposed, and the carbonates formed by the new combinations thence arising must often augment the

volume of the altered rocks. This increase of bulk, he says, must sometimes give rise to mechanical force of expansion capable of uplifting the incumbent crust of the earth; and the same force may act laterally so as to compress, dislocate, and tilt the strata on each side of a mass in which the new chemical changes are developed. The calculations made by this eminent German chemist of the exact amount of distention which the origin of new mineral products may cause, by adding to the volume of the rocks, deserve the attention of geologists, as affording them aid in explaining those reiterated oscillations of level—those risings and sinkings of land—which have occurred on so grand a scale at successive periods of the past. There are probably many distinct causes of such upward, downward, and lateral movements, and any new suggestion on this head is most welcome; but I believe the expansion and contraction of solid rocks, when they are alternately heated and cooled, and the fusion and subsequent consolidation of mineral masses, will continue to rank, as heretofore, as the most influential causes of such movements.

The temperature of the Bath waters varies in the different springs from 117° to 120° F. This, as before stated, is exceptionally high, when we duly allow for the great distance of Bath from the nearest region of active or recently extinct volcanoes and of violent earthquakes. The hot-springs of Aix-la-Chapell have a much higher temperature, viz. 135° F., but they are situated within forty miles of those cones and lava-streams of the Eifel which, though they may have spent their force ages before the earliest records of history, belong, nevertheless, to the most modern geological period. Bath is about 400 miles distant from the same part of Germany, and 440 from Auvergne—another volcanic region, the latest eruptions of which were geologically coëval with those of the Eifel. When these two regions in France and Germany were the theatres of frequent convulsions, we may well suppose that England was often more rudely shaken than now; and such shocks as that of October last, the sound and rocking motion of which caused so great a sensation as it traversed the southern part of the island, and seems to have been particularly violent in Herefordshire, may be only a languid reminder to us of a force of which the energy has been gradually dying out.

But there are other characters in the structure of the earth's crust more mysterious in their nature than the phenomena of metalliferous veins, on which the study of hot-springs has thrown

light—I allude to the metamorphism of sedimentary rocks. Strata of various ages, many of them once full of organic remains, have been rendered partially or wholly crystalline. It is admitted on all hands that heat has been instrumental in bringing about this re-arrangement of particles, which, when the metamorphism has been carried out to its fullest extent, obliterates all trace of the imbedded fossils. But as mountain-masses many miles in length and breadth, and several thousands of feet in height, have undergone such alteration, it has always been difficult to explain in what manner an amount of heat capable of so entirely changing the molecular condition of sedimentary masses could have come into play without utterly annihilating every sign of stratification, as well as of organic structure.

Various experiments have led to the conclusion that the minerals which enter most largely into the composition of the metamorphic rocks have not been formed by crystallizing from a state of fusion, or in the dry way, but that they have been derived from liquid solutions, or in the wet way—a process requiring a far less intense degree of heat. Thermal springs, charged with carbonic acid and with hydro-fluoric acid (which last is often present in small quantities), are powerful causes of decomposition and chemical reaction in rocks through which they percolate. If, therefore, large bodies of hot water permeate mountain-masses at great depths, they may in the course of ages superinduce in them a crystalline structure; and in some cases strata in a lower position and of older date may be comparatively unaltered, retaining their fossil remains undefaced, while newer rocks are rendered metamorphic. This may happen where the waters, after passing upwards for thousands of feet, meet with some obstruction, as in the case of the Wheal-Clifford spring, causing the same to be laterally diverted so as to percolate the surrounding rocks. The efficacy of such hydro-thermal action has been admirably illustrated of late years by the experiments and observations of Sénarmont, Daubrée, Delesse, Scheerer, Sorby, Sterry Hunt, and others.

The changes which Daubrée has shown to have been produced by the alkaline waters of Plombières, in the Vosges, are more especially instructive. These thermal waters have a temperature of 160° F., and were conveyed by the Romans to baths through long conduits or aqueducts. The foundations of some of their works consisted of a bed of concrete made of lime, fragments of brick, and sandstone. Through this and other masonry the hot waters have

been percolating for c nturies, and have given rise to various zeolites—apophyllite and chabazite among others; also to calcareous spar, arragonite, and fluor spar, together with siliceous minerals, such as opal,—all found in the interspaces of the bricks and mortar, or constituting part of their rearranged materials. The quantity of heat brought into action in this instance in the course of 2000 years has, no doubt, been enormous, although the intensity of it developed at any one moment has been always inconsiderable.

The study, of late years, of the constituent parts of granite has in like manner led to the conclusion that their consolidation has taken place at temperatures far below those formerly supposed to be indispensable. Gustav Rose has pointed out that the quartz of granite has the specific gravity of 2·6, which characterizes silica when it is precipitated from a liquid solvent, and not that inferior density, namely 2·3, which belongs to it when it cools and solidifies in the dry way from a state of fusion.

But some geologists, when made aware of the intervention on a large scale, of water, in the formation of the component minerals of the granitic and volcanic rocks, appear of late years to have been too much disposed to dispense with intense heat when accounting for the formation of the crystalline and unstratified rocks. As water in a state of solid combination enters largely into the aluminous and some other minerals, and therefore plays no small part in the composition of the earth's crust, it follows that, when rocks are melted, water must be present, independently of the supplies of rain-water and sea-water which find their way into the regions of subterranean heat. But the existence of water under great pressure affords no argument against our attributing an excessively high temperature to the mass with which it is mixed up. Still less does the point to which the melted matter must be cooled down before it consolidates or crystallizes into lava or granite afford any test of the degree of heat which the same matter must have acquired when it was melted and made to form lakes and seas in the interior of the earth's crust.

The evidence of a period of great cold in England and North America, in the times referred to, is now so universally admitted by geologists, that I shall take it for granted in this Address, and briefly consider what may have been the probable causes of the refrigeration of central Europe at the era in question. One of these causes, first suggested eleven years ago by a celebrated Swiss geo-

logist, has not, I think, received the attention which it well deserved. When I proposed, in 1833, the theory that alterations in physical geography might have given rise to those revolutions in climate which the earth's surface has experienced at successive epochs, it was objected by many that the signs of upheaval and depression were too local to account for such general changes of temperature. This objection was thought to be of peculiar weight when applied to the glacial period, because of the shortness of the time, geologically speaking, which has since transpired. But the more we examine the monuments of the ages which preceded the historical, the more decided become the proofs of a general alteration in the position, height, and depth of seas, continents, and mountain-chains since the commencement of the glacial period. The meteorologist also has been learning of late years that the quantity of ice and snow in certain latitudes depends not merely on the height of mountain-chains, but also in the distribution of the surrounding sea and land even to considerable distances.

M. Escher von der Linth gave it as his opinion in 1852, that if it were true, as Ritter had suggested, that the great African desert, or Sahara, was submerged within the modern or post-tertiary period, the same submergence might explain why the Alpine glaciers had attained so recently those colossal dimensions which, reasoning on geological data, Venetz and Charpentier had assigned to them. Since Escher first threw out this hint, the fact that the Sahara was really covered by the sea at no distant period has been confirmed by many new proofs. The distinguished Swiss geologist himself has just returned from an exploring expedition through the eastern part of the Algerian desert, in which he was accompanied by M. Desor, of Neuchatel, and Professor Martins, of Montpellier. These three experienced observers satisfied themselves, during the last winter, that the Sahara was under water during the period of the living species of Testacea. We had already learnt in 1856, from a memoir by M. Charles Laurent, that sands identical with those on the nearest shores of the Mediterranean, and containning, among other recent shells, the common cockle (*Cardium edule*), extend over a vast space from west to east in the desert, being not only found on the surface, but also brought up from depths of more than 20 feet by the Artesian auger. These shells have been met with at heights of more than 900 feet above the sea-level, and on ground sunk 300 feet below it; for there are in Africa, as in Western Asia, depressions of land below the level o

the sea. The same cockle has been observed still living in several salt-lakes in the Sahara: and superficial incrustations in many places seem to point to the drying up by evaporation of several inland seas in certain districts.

Mr. Tristram, in his travels in 1859, traced for many miles along the southern borders of the French possessions in Africa lines of inland sea-cliffs, with caves at their bases, and old sea-beaches forming successive terraces, in which recent shells and the casts of them were agglutinated together with sand and pebbles, the whole having the form of a conglomerate The ancient sea appears once to have stretched from the Gulf of Cabes, in Tunis, to the west coast of Africa north of Senegambia, having a width of several hundred (perhaps where greatest, according to Mr. Tristram, 800) miles. The high lands of Barbary, including Morocco, Algeria, and Tunis, must have been separated at this period from the rest of Africa by a sea. All that we have learnt from zoologists and botanists in regard to the present fauna and flora of Barbary favors this hypothesis, and seems at the same time to point to a former connexion of that country with Spain, Sicily, and South Italy.

When speculating on these changes, we may call to mind that certain deposits, full of marine shells of living species, have long been known as fringing the borders of the Red Sea, and rising several hundred feet above its shores. Evidence has also been obtained that Egypt, placed between the Red Sea and the Sahara, participated in these great continental movements. This may be inferred from the old river-terraces, lately described by Messrs. Aaams and Murie, which skirt the modern alluvial plains of the Nile, and rise above them to various heights, from 30 to 100 feet and upwards. In whatever direction, therefore, we look, we see grounds for assuming that a map of Africa in that glacial period would no more resemble our present maps of that continent than Europe now resembles North America. If, then, argues Escher, the Sahara was a sea in post-tertiary times, we may understand why the Alpine glaciers formerly attained such gigantic dimensions, and why they have left moraines of such magnitude on the plains of northern Italy and the lower country of Switzerland. The Swiss peasants have a saying, when they talk of the melting of the snow, that the sun could do nothing without the Föhn, a name which they give to the well-known sirocco. This wind, after sweeping over a wide expanse of parched and burning sand in Africa, blows occasionally for days in succession across the Mediterranean, carrying with it the scorch-

ing heat of the Sahara to melt the snows of the Appennines and Alps.

M. Denzler, in a memoir on this subject, observes that the Föhn blew tempestuously at Algiers on the 17th July 1841, and then, crossing the Mediterranean, reached Marseilles in six hours. In five more hours it was at Geneva and the Valais, throwing down a large extent of forest in the latter district, while in the cantons of Zurich and the Grisons it suddenly turned the leaves of many trees from green to yellow. In a few hours new mown grass was dried and ready for the haystack; for although, passing over the Alpine snows, the sirocco absorbs much moisture, it is still far below the point of saturation when it reaches the sub-Alpine country to the north of the great chain. MM. Escher and Denzler have both of them observed on different occasions that a thickness of one foot of snow has disappeared in four hours during the prevalence of this wind. No wonder, therefore, that the Föhn is so much dreaded for the sudden inundations which it sometimes causes. The snow-line of the Alps was seen by Mr. Irscher, the astronomer, from his observatory at Neuchatel, by aid of the telescope, to rise sensibly every day while this wind was blowing. Its influence is by no means confined to the summer season, for in the winter of 1852 it visited Zurich at Christmas, and in a few days all the surrounding country was stripped of its snow, even in the shadiest places and on the crests of high ridges. I feel the better able to appreciate the power of this wind from having myself witnessed in Sicily, in 1828, its effect in dissolving, in the month of November, the snows which then covered the summit and higher parts of Mount Etna. I had been told that I should be unable to ascend to the top of the highest cone till the following spring; but in thirty-six hours the hot breath of the sirocco stripped off from the mountain its white mantle of snow and I ascended without difficulty.

It is well known that the number of days during which particular winds prevail, from year to year, varies considerably. Between the years 1812 and 1820 the Föhn was less felt in Switzerland than usual; and what was the consequence? All the glaciers, during those eight or nine years, increased in height, and crept down below their former limits in their respective valleys. Many similar examples might be cited of the sensitiveness of the ice to slight variations of temperature. Captain Godwin-Austen has lately given us a description of the gigantic glaciers of the western Himalaya

in those valleys where the sources of the Indus rise, between the latitudes 35° and 36° N. The highest peaks of the Karakorum range attain in that region an elevation of 28,000 feet above the sea. The glaciers, says Captain Austen, have been advancing, within the memory of the living inhabitants, so as greatly to encroach on the cultivated lands, and have so altered the climate of adjoining valleys immediately below, that only one crop a year can now be reaped from fields which formerly yielded two crops. If such changes can be experienced in less than a century, without any perceptible modification in the physical geography of that part of Asia, what mighty effects may we not imagine the submergence of the Sahara to have produced in adding to the size of the Alpine glaciers? If, between the years 1812 and 1820, a mere diminution of the number of days during which the sirocco blew could so much promote the growth and onward movement of the ice, how much greater a change would result from the total cessation of the same wind! But this would give no idea of what must have happened in the glacial period; for we cannot suppose the action of the south wind to have been suspended; it was not in abeyance, but its character was entirely different, and of an opposite nature, under the altered geographical conditions above contemplated. First, instead of passing over a parched and scorching desert, between the twentieth and thirty-fifth parallels of latitude, it would plentifully absorb moisture from a sea many hundreds of miles wide. Next, in its course over the Mediterranean, it would take up still more aqueous vapor; and when, after complete saturation, it struck the Alps, it would be driven up into the higher and more rarified regions of the atmosphere. There the aërial current, as fast as it was cooled, would discharge its aqueous burden in the form of snow, so that the same wind which is now called "the devourer of ice" would become its principal feeder.

If we thus embrace Escher's theory, as accounting in no small degree for the vast size of the extinct glaciers of Switzerland and Northern Italy, we are by no means debarred from accepting at the same time Charpentier's suggestion, that the Alps in the glacial period were 2000 or 3000 feet higher than they are now. Such a difference in altitude may have been an auxiliary cause of the extreme cold, and seems the more probable now that we have obtained unequivocal proofs of such great oscillations of level in Wales within the period under consideration. We may also avail ourselves of another source of refrigeration which may have coin-

cided in time with the submergence of the Sahara, namely, the diversion of the Gulf-stream from its present course. The shape of Europe and North America, or the boundaries of sea and land, departed so widely in the glacial period from those now established, that we cannot suppose the Gulf-stream to have taken at that period its present north-western course across the Atlantic. If it took some other direction, the climate of the north of Scotland would, according to the calculations of Mr. Hopkins, suffer a diminution in its average annual temperature of 12° F., while that of the Alps would lose 2° F. A combination of all the conditions above enumerated would certainly be attended with so great a revolution in climate as might go far to account for the excessive cold which was developed at so modern a period in the earth's history. But even when we assume all three of them to have been simultaneous in action, we have by no means exhausted all the resources which a difference in the geographical condition of the globe might supply. Thus, for example, to name only one of them, we might suppose that the height and quantity of land near the north pole was greater at the era in question than it is now.

The vast mechanical force that ice exerted in the glacial period has been thought by some to demonstrate a want of uniformity in the amount of energy which the same natural cause may put forth at two successive epochs. But we must be careful, when thus reasoning, to bear in mind that the power of ice is here substituted for that of running water. The one becomes a mighty agent in transporting huge erratics, and in scoring, abrading, and polishing rocks; but meanwhile the other is in abeyance. When, for example, the ancient Rhone glacier conveyed its moraines from the upper to the lower end of the Lake of Geneva, there was no great river, as there now is, forming a delta many miles in extent, and several hundred feet in depth, at the upper end of the lake.

The more we study and comprehend the geographical changes of the glacial period, and the migrations of animals and plants to which it gave rise, the higher our conceptions are raised of the duration of that subdivision of time, which, though vast when measured by the succession of events comprised in it, was brief, if estimated by the ordinary rules of geological classification. The glacial period was, in fact, a mere episode in one of the great epochs of the earth's history; for the inhabitants of the lands and seas, before and after the grand development of snow and ice, were nearly the same. As yet we have no satisfactory proof that

man existed in Europe or elsewhere during the period of extreme cold; but our investigations on this head are still in their infancy.

In an early portion of the postglacial period it has been ascertained that man flourished in Europe; and in tracing the signs of his existence, from the historical ages to those immediately antecedent, and so backward into more ancient times, we gradually approach a dissimilar geographical state of things, when the climate was colder, and when the configuration of the surface departed considerably from that which now prevails.

I will now briefly allude, in conclusion, to two points on which a gradual change of opinion has been taking place among geologists of late years. First, as to whether there has been a continuous succession of events in the organic and inorganic worlds, uninterrupted by violent and general catastrophes; and secondly, whether clear evidence can be obtained of a period antecedent to the creation of organic beings on the earth. I am old enough to remember when geologists dogmatized on both these questions in a manner very different from that in which they would now venture to indulge. I believe that by far the greater number now incline to opposite views from those which were once most commonly entertained. On the first point it is worthy of remark, that, although a belief in sudden and general convulsions has been losing ground, as also the doctrine of abrupt transitions from one set of species of animals and plants to another of a very different type, yet the whole series of the records which have been handed down to us are now more than ever regarded as fragmentary. They ought to be looked upon as more perfect, because numerous gaps have been filled up; and in the formations newly intercalated in the series we have found many missing links and various intermediate gradations between the nearest allied forms previously known in the animal and vegetable worlds. Yet the whole body of monuments which we are endeavoring to decipher appears more defective than before. For my own part, I agree with Mr. Darwin in considering them as a mere fraction of those which have once existed, while no approach to a perfect series was ever formed originally, it having never been part of the plan of Nature to leave a complete record of all her works and operations for the enlightenment of rational beings who might study them in after-ages.

In reference to the other great question, or the earliest date of vital phenomena on this planet, the late discoveries in Canada have at least demonstrated that certain theories founded in Europe on

mere negative evidence were altogether delusive. In the course of a geological survey, carried on under the able direction of Sir William E. Logan, it has been shown that northward of the river St. Lawrence there is a vast series of stratified and crystalline rocks of gneiss, mica-schist, quartzite, and limestone, about 40,000 feet in thickness, which have been called Laurentian.

They are more ancient than the oldest fossiliferous strata of Europe, or those to which the term primordial had been rashly assigned. In the first place, the newest part of this great crystalline series is unconformable to the ancient fossiliferous or so-called primordial rocks which overlie it; so that it must have undergone disturbing movements before the latter or primordial set were formed. Then again, the older half of the Laurentian series is unconformable to the newer portion of the same. It is in this lowest and most ancient system of crystalline strata that a limestone, about a thousand feet thick, has been observed, containing organic remains. These fossils have been examined by Dr. Dawson, of Montreal, and he has detected in them, by aid of the microscope, the distinct structure of a large species of Rhizopod. Fine specimens of this fossil, called *Eozoon Canadense*, have been brought to Bath by Sir William E. Logan, to be exhibited to the members of the Association. We have every reason to suppose that the rocks in which these animal remains are included are of as old a date as any of the formations named azoic in Europe, if not older, so that they preceded in date rocks once supposed to have been formed before any organic beings had been created.

But I will not venture on speculations respecting "the signs of a beginning," or "the prospects of an end," of our terrestrial system—that wide ocean of scientific conjecture on which so many theorists before my time have suffered shipwreck. Without trespassing longer on your time, I will conclude by expressing to you my thanks for the honor you have done me in asking me to preside over this meeting. I have every reason to hope, from the many members and distinguished strangers whom I already see assembled here, that it will not be inferior in interest to any of the gatherings which have preceded it.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above level of the Sea 182 feet. For the month of September, 1864.

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

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Cloud in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.	Remarks for the Month.
	Highest	Lowest.	Mean.	Max.	Min.	Mean										
	Inches.	Inches.	Inches													
1	29.993	29.897	29.966	88.1	53.0	72.3	.628	.775	W bys	114.80	3.3	....	....	1.0		Barometer .. Highest, the 7th day, 30.195 inches.
2	.878	.819	.841	76.0	53.1	66.1	.522	.792	N E	99.30	9.6	....	....	1.3		Barometer .. Lowest, the 15th day, 29.421 "
3	.759	.724	.741	64.2	51.0	59.1	.481	.889	N E	60.69	10.0	0.689	....	2.6	Rain.	Barometer .. Monthly Mean, 29.773 "
4	.742	.721	.727	59.1	54.2	51.1	.422	.891	N E	139.29	10.0	0.942	....	2.6	Rain.	Barometer .. Monthly Range, 0.774 "
5	.906	.867	.889	65.2	48.2	58.0	.455	.907	N E	100.29	5.3	....	....	2.3	Au. Bor.	
6	30.069	.000	30.049	88.0	48.0	67.9	.555	.793	N N E	77.59	0.0	....	....	1.3		Thermometer Highest, the 6th day 88.0.
7	.195	30.101	.193	75.7	47.0	58.6	.467	.861	W N W	11.79	0.0	....	....	1.3		Thermometer Lowest, the 26th day, 32.9.
8	29.984	29.959	29.961	72.1	48.2	61.1	.475	.842	N E	54.31	6.6	....	....	1.0		Thermometer Monthly Mean, 58.91.
9	.764	.624	.689	69.1	48.3	62.2	.417	.803	S W	90.40	8.0	0.031	....	2.0	Rain.	Thermometer Monthly Range, 55.1.
10	.624	.553	.596	61.2	48.1	58.4	.428	.874	N W	138.74	5.3	. ..	....	2.0		Greatest intensity of the Sun's rays, 111°.9.
11	.673	.641	.674	65.9	51.2	60.1	.457	.878	N E	90.30	9.6	....	....	2.0		Lowest point of Terrestrial radiation, 31°.7.
12	.757	.616	.705	57.2	49.1	50.3	.372	.925	N E	90.07	10.0	0.084	....	3.0	Rain.	Mean of Humidity, .870.
13	.679	.617	.657	54.7	48.0	52.8	.355	.903	N E	152.20	10.0	0.171	....	3.0	Rain.	Rain fell on 19 days, amounting to 3.482 inches, it was accompanied by Thunder on 1 day.
14	.641	.576	.597	60.9	46.8	55.9	.407	.903	N E	227.14	10.0	0.171	....	2.3	Rain.	Most prevalent wind, N. E.
15	.500	.421	.454	58.1	54.2	55.1	.445	.954	W S W	33.50	10.0	0.160	....	2.3	Rain.	Least prevalent wind, N. N. E.
16	.554	.472	.519	54.2	47.9	52.1	.393	.893	W S W	188.75	8.0	0.302	....	1.6	Rain.	Most windy day the 27th day, mean miles per hour, 10.54.
17	.809	.779	.814	72.2	43.3	58.8	.480	.909	W N W	103.25	1.3	0.054	....	2.0	Rain—A.Bor.	
18	.809	.569	.727	74.6	57.1	64.4	.568	.917	W	203.60	8.0	...	....	2.3	Lightning.	Least windy day, the 25th day, mean miles per hour, 1.39.
19	.709	.473	.629	69.1	44.7	58.1	.448	.898	S W	120.70	10.0	0.162	....	2.6	Rain.	
20	.807	.716	.772	70.9	43.2	58.4	.382	.872	W S W	135.80	8.0	Inapp	....	2.0	Rain.	Amount of Evaporation 1.17 inches.
21	.807	.749	.785	64.7	48.7	58.2	.423	.851	W S W	79.40	8.0	Inapp	....	1.6	Rain.	Aurora Borealis visible on 2 nights.
22	30.011	.873	.922	69.2	53.7	59.1	.323	.870	N E	82.68	5.3	Inapp	....	1.3	Rain.	
23	29.759	.598	.676	81.0	64.1	65.6	.555	.886	N by W	100.26	7.6	....	....	1.0		
24	.521	.507	.515	69.4	63.4	64.2	.544	.886	S W	142.49	7.6	Inapp	....	2.0	Rain.	
25	.771	.710	.727	75.9	46.1	51.3	.327	.846	N E	70.15	6.6	0.261	....	2.0	Rain.	
26	.824	.770	.811	69.4	32.9	50.7	.351	.873	S W	121.40	1.3	..	....	1.3		
27	.704	.583	.595	76.4	37.4	54.6	.454	.884	W	271.95	6.0	0.140	....	3.0	Rain.	
28	30.061	.000	.833	76.9	48.4	65.5	.541	.873	W	191.49	4.6	0.064	....	1.3		
29	.026	.599	.842	62.3	40.9	55.5	.392	.846	W	103.56	9.6	Inapp	....	2.0	Rain.	
30	.109	.804	.968	61.1	43.0	51.6	.313	.868	W	224.60	3.3	0.872	....	3.3	Rain.	