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Hints for the Formation of a Canadian Collection of Ancient Crania.

The value which attaches to ancient skulls as indices of the characteristics of extinct races, is being more and more generally appreciated with the increasing results of extended observation. Camper, the originator of the ideal facial angle, was the first of modern scientific craniologists who aimed at establishing a system of classifying races by means of cranial conformation; and with him must be noted Daubenton, the contemporary and fellow-labourer of Buffon, who first drew attention to some of the most remarkable elements of comparison, in the characteristics of the base of the skull, both in comparative anatomy, as between the ape and man, and between the known races of men, as the Negro and European. These were followed by Blumenbach, to whom we owe the accepted application of some of the most familiar ethnological terms, such as Mongolian, Ethiopian, and, above all, *Caucasian*. Of these the last was undoubtedly founded on error, and, as now commonly employed, has a falser and more misleading import than any it was designed to convey by its originator. Hunter, Cuvier, and other naturalists, more or less incidentally noticed the same elements of comparison, and Dr. Prichard, with a rare combination of learning and powers of observation, began so early as 1808, by the publication of his *De Hominum Varietatibus*, a series of works which have exercised the most important influence on the science of Ethnology.

While the latter of these works were in progress, a distinguished American physiologist, Dr. Samuel George Morton of Philadelphia, devoted himself to craniological investigation with a special view to the elucidation of the many obscure points relative to the ancient and existing native races of the new world. The first task he proposed to himself was the examination and comparison of the crania of the Indian tribes of North and South America. In following out his investigation he enlisted many zealous coadjutors in his service, and obtained skulls from ancient Mexican and Peruvian sepulchres, and from the grave mounds of the Southern States and of Central America. The first fruits of this was the publication, in 1839, of his *Crania Americana*, a work of the utmost value in this department of physical ethnology. Dr. Morton next proceeded to extend his labours into the most ancient areas of human colonisation, and with the aid of Mr. G. R. Gliddon, the United States Consul at Cairo, in Egypt, he obtained an important collection of skulls from the venerable catacombs of the Nile valley. The result of this was the publication of another work, the *Crania Ægyptiaca*, in 1844, which met with the highest commendations from the Archæologists and Ethnologists of Europe. Dr. Morton's death took place in 1851, while engaged in the prosecution of researches calculated still further to elucidate the science to which he had already made such valuable contributions. The extensive collection of crania which he had made, including those which furnished the data for the two great works named above, has since been purchased from his widow and added to the Cabinet of Natural Sciences of Philadelphia.

European Ethnologists have not failed to appreciate the importance of such observations, and valuable collections of ancient crania are now to be met with in Paris, Stockholm, Copenhagen, Edinburgh, and other European capitals. Especial attention has more recently been directed to the subject in Britain, and a work is now projected by Joseph Barnard Davis, Esq., and Dr. John Thurnam, after the model of Dr. Morton's *Crania Americana*, specially devoted to the illustration of the Ethnology of Great Britain and Ireland by means of "delineations of the skulls of the aboriginal inhabitants of the British Islands, and of the races immediately succeeding them."

The following extract from the prospectus of this work, which is to bear the title of *Crania Britannica*, will suffice to show the aim of its authors, and the nature of the truths they hope to elucidate:—

"Amid an attention to the Natural History of Man, such as has never before been excited, embracing the inhabitants of every region and remote island of the globe, it seems an anomaly, that the people who first roamed the wilds and forests of our native country should have hitherto attracted so little regard. There have been many controversies to decide the exact position held by the ancient Britons in the scale of civilization. Antiquaries have appealed to the numerous relics of their arts, and history adduces evidences of their prowess, their patriotic valour, and of their heroic resistance of even Roman conquest. Their remaining works have been traced out and deciphered with the most patient investigation. But it is remarkable, that their personal remains—their bones,—entombed in Barrows over so many districts of these islands, have, until recently, not been objects of attraction even to collectors,—unlike the geologist, who has gathered up and treasured every osteological fragment of the races of animals coming within his domain. Hitherto no publication has been devoted to the chief vestige of the organization of the primitive Briton and his successors, that most important and instructive of all—his Cranium. In the skulls themselves, we have the very "heart of heart" of all their remains, which the gnawing "tooth of time and razure of oblivion" have spared. These present an exact measure of their differing cerebral organization, of their intellect and feelings; and may be said to be impressed with a vivid outline of their very features and expressions.

It is believed that a sufficient number of these precious relics have now been exhumed from Barrows and other Tombs, in which the living hands of their brethren (observing the dictates of eternal love, or the rites of an all-pervading superstition, based in inextinguishable aspirations) deposited them, to enable us not merely to reproduce the most lively and forcible traits of the primæval Celtic hunter or warrior, and his Roman conqueror, succeeded by Saxon or Angle chieftains and settlers, and, later still, by the Vikings of Scandinavia; but also to indicate the peculiarities which marked the different tribes and races who have peopled the diversified regions of the British Islands; and as we thus picture our varied ancestry, to deduce, at the same time, their position in the scale of civilization by the tests of acurate representation and admeasurement.

These primitive remains are of great interest—of real national value,—and deserve the most careful examination and study, that they may be delineated with the utmost precision—with artistic skill worthy of the subject; and, being thus perpetuated, they will be rescued from the grasp of accidental destruction, and the further inroads of fretting age.

In some countries of Europe, collections of Crania, such as are above alluded to, have thrown much light on the history and relations of the early races inhabiting them. The results obtained from researches of this kind in the Scandinavian kingdoms, have been presented to the world in the writings of Eschricht, Retzius, and Nilsson. In America, the great master of the science, the late Professor Morton, founded his classical works on the Aborigines of the Western World and the ancient Egyptians, upon skulls obtained from the mounds and burial-places of the former, and the Catacombs of the land of the Pharaohs. In our own country, as Dr. Prichard, our best ethnological authority, repeatedly laments, nothing of the kind, except on the most inadequate scale, has yet been attempted. Few countries, however, present greater facilities for an inquiry of this description."

The authors accordingly propose to issue this work by subscription, in six parts of an imperial quarto size, each containing ten lithographic plates, accompanied with a descriptive narrative, giving the history of each exhumation, an account of any antiquities disinterred with it, and also, when necessary, illustrations of such, along with exact measurements of the skulls, similar to those furnished by Dr. Morton. The collections of the Society of Antiquaries of Scotland, the Phrenological Society of Edinburgh, the Royal Academy of Dublin, and of various other scientific bodies, have been placed at the service of the authors, and both the Royal Society of London and the British Association for the advancement of Science have granted pecuniary aid towards the requisite investigations.

When the importance of such evidences of the physical characteristics both of extinct and living races, in relation to historical investigation, is thus becoming so widely appreciated, it appears to be desirable that Canada should not lag behind in the good work. Such a collection of native Crania as that with which Dr. Morton has enriched the Cabinet of the Academy of Sciences of Philadelphia, would form a valuable addition to the museum of the Canadian Institute, and many facilities undoubtedly exist for its attainment. Every year agricultural operations are extending into new districts, and breaking up virgin soil. In the progress of clearing the ancient forests, and bringing the land into cultivation, places of sepulture must frequently be invaded, where the remains of the long-buried chief lie undisturbed, alongside of specimens of the rude arts which furnish proofs of the condition of society to which he belonged. Railway and other operations are in like manner leading to numerous extensive excavations in regions hitherto untouched by the spade or plough; and these also must frequently expose to view similar relics of the ancient or more recently displaced aborigines. It is scarcely to be hoped that the rude railway navvy, or even the first agricultural explorers of the wild lands of the North and West, will greatly interest themselves in objects of scientific curiosity; but now that the members of the Canadian Institute are scattered over nearly every district of the Province, it may be hoped they will be found prepared for hearty coöperation in all such objects, and that by such means the museum of the Institute may become, through time, an object of just pride and interest to the community at large.

In many cases the condition in which the skulls and other remains of the former occupants of our Canadian clearings are found, is such as to present no obstacle to their ready transmission for the purpose in view. It is to be noted, however, that the more ancient such remains are, they are likely to possess the greater interest and value. No indications have yet been noticed of a race in Canada corresponding to the Brachy-kephalic or square-headed mound builders of the Mississippi, and the discovery of such would furnish an addition of much importance to our materials for the primeval history of the Great Lake districts, embracing Canada West. Such remains, if found at all, are likely to be in a very fragile state, and will require much care in their removal. As it is not to be doubted that zealous coöperators in the object here referred to will be found among the members of the Institute, it may not be altogether useless to add a few hints relative to the collecting and preserving such ancient remains. It is not to be overlooked indeed, that the entire skeleton, as well as the skull, frequently presents features of interest and value, as evidence of peculiar distinctions of race, or as traces of habits and conditions of life, to those who have made such remains their special study. It is manifestly, however, only under very rare and peculiar circumstances that it can be expedient or even desirable to have the entire skeleton preserved. But the decision of this point must be left to each explorer.

In the first place then, let it be noted that it is desirable to possess the whole of the bones of the head and face, including the lower jaw and the teeth. The slender and fragile bones of the nose are of special importance, and when remaining in their place should be carefully protected from injury. In all cases they are highly characteristic, and in none more so than in the races of American Indians, whose strongly-marked profiles derive their chief character from the prominence and peculiar form of the nose. It is also to be observed in the case of remains found under circumstances indicative of great antiquity, and consequently possessing peculiar value for the purposes in view, that though the bones may be wholly disjointed and even fractured, if the whole, or the greater number of the fragments be collected, and carefully packed so as to protect them from further injury, it may be quite possible to rejoin them, and so reconstruct the ancient cranium. The following incident derived from the experience of Dr. Morton, may suffice as an illustration of this :—

In the summer of 1842, a friend of his met in New York the well known American traveller, Mr. John S. Stevens, then recently returned from his second visit to Yucatan. The conversation turning upon Crania, Mr. Stevens regretted the destruction of all he had collected during his travels in consequence of their extreme brittleness. One skeleton he had hoped to save, but on unpacking it that morning, it was found so dilapidated that he had ordered it to be thrown away. A sight of it was immediately requested,—it was secured in its fragmentary and apparently hopeless condition, and forwarded to Dr. Morton. Its condition may be inferred from the fact that the entire skeleton was tied up in a small handkerchief, and carried from New York to Philadelphia in a hat-box. The next day, however, Dr. Morton was found with a gluepot beside him, industriously engaged in an effort to reconstruct the skull. A small piece of the occiput served as a basis, upon which he put together all the posterior portion of the cranium, showing it by characteristic marks to be that of an adult female. From the condition of another portion of the skeleton he derived evidence of a pathological fact of considerable moment, when viewed in relation to the antiquity indicated by the accompanying relics, and the peculiar circumstances under which this skeleton had been found; and the results of his observations, which have been published by Mr. Stevens in the narrative of his second visit to Yucatan, suffice to show how much interesting and valuable information may be deduced by the intelligent student of science from what, to the ordinary observer, would appear to be a mere handful of rubbish.

In Canada it is to be presumed that, in the great majority of cases, such remains will be discovered by chance, and their preservation from further injury in the hands of their original exhumers will be more a matter of accident than design. By and by, however, we may hope to create an intelligent interest in this department of scientific inquiry, and so find zealous explorers of the sepulchral chronicles of Canada, as well as of those of Egypt, Britain, or Central America. To such, a few additional hints may be of value.

Whether it be a grave-mound, ossuary, or cemetery, that is being explored, the ruder instruments of excavation, such as the pick-axe and spade, should be laid aside as soon as any portion of a skull or skeleton has been exposed. The whole must then be cleared from the surrounding earth by means of some light implement, such as a garden trowel, with the assistance of the hand. In removing the earth strict attention should be paid to any small objects contained in it: as the practice of the Indians of this continent, as well as of most other savage races, of burying weapons, implements, and personal ornaments with the dead is well known. The better to avoid any injury to the more essential parts, it is advisable, where it can be done without great inconvenience, to pursue the final process of laying bare the skeleton, by proceeding from the feet towards the head. The bones ought not to be attempted to be removed from the inclosing soil when they indicate the slightest fragility, until the earth has been cautiously removed all round them, so as to admit of their being lifted out. Where the skull has been fractured, or any of the bones of the face are crushed or displaced by the pressure of the earth, every fragment, however small, should be carefully collected; and if the soil has been damp, or the bones are rendered soft by moisture, they should be exposed to the sun, before being wrapped up in paper.

Care should also be taken to note all the circumstances attendant on the discovery, which are likely to throw any light on the characteristics of the race, their mode of sepulture, or their arts, customs, or habits. Nothing should be trusted to memory, but all the facts noted at the moment and on the spot. Some of the most important of the facts to be observed and noted down are: The position of the body, whether lying at full length, on the back or side, or with the knees bent or drawn up; also the direction of the body, and position of the head in relation to the points of the compass.

Next the nature and relative position of any relics, such as urns, implements, weapons, &c., should be carefully noted; and among such, particular attention is to be paid to animal remains, such as the bones and skulls, horns or teeth, of beasts, birds and fishes. It is a common fashion among savage tribes to hold a burial feast over the grave of the dead, and such relics may tend to throw considerable light on the habits of the people, as well as on the period to which they belong.

In transmitting ancient skulls, they should be first wrapped up in paper,—an old newspaper will be found the most suitable for the purpose. Where there are detached pieces each should be put up in a separate wrapper. The whole may then be put in a box with a little hay, which furnishes an inclosure sufficiently elastic to protect the most fragile bones from injury during carriage.

As such relics loose much of their value when the locality and circumstances of their discovery are unknown, it is extremely desirable not only to attach to each skull, package of bones, or accompanying relics, the name and description of the locality where they have been found, but also as soon as possible to mark this neatly and indelibly upon the object itself. Where more than one skull has been procured, and any of them are in a fragmentary state, it is scarcely necessary to add that the utmost care should be taken to keep the several portions of each skull distinct from the others; as even where it may be possible afterwards to separate them, this must always be attended with much additional labour, and generally with some uncertainty. It may be further added that in no case should a skull, or other relic of this class, be deposited finally in a collection, without a distinct note of the locality of its discovery being marked on it in a durable manner.

D. W.

On the Extent to which the received Theory of Vision requires us to regard the Eye as a Camera Obscura.

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In the last issue of the Transactions of the Royal Society of Edinburgh,* a highly interesting paper bearing the above title furnishes views on the structure and function of the eye in relation to vision, which will tend to modify to a very considerable extent the views of physiologists on this important subject. Dr. Wilson takes it for granted that, according to the received theory of vision, the eye of man, as well as that of most of the lower animals, is regarded as essentially realizing, during the performance of its function of sight, the condition of a darkened chamber, or *camera obscura*. In support of this assumption of the existing views of physiologists, he cites one of the highest living authorities, Professor Müller, and then proceeds to say:—"Thus far, then, there does not appear to be room for two opinions concerning the internal darkness of the human eye being a condition of perfect sight. But recent discoveries require us to look at the theory of vision from an opposite point of view. It is now beyond question, that even in the darkest human eye, there is reflection through or across its chamber, from the surface of the retina, as well as from that of the choroid; and the observation is a very old one, that in a large number of animals, a part, and sometimes the whole of the retinal surface is covered, or replaced by a reflector rivalling in brilliancy a sheet of polished silver.

"That the eyes of living men and women emitted light, and shone like those of the cat, had been occasionally noticed and recorded from an early time, but the phenomenon was supposed to be an exceptional, and indeed very rare one, and was either credulously magnified into a highly marvellous occurrence, or despised as of questionable accuracy, and of little real significance. In (or about) 1847, however, Mr. Cumming, an English medical practitioner, pointed out that the phenomenon in question might be witnessed in every human eye, if looked for in the right way; and a little later and independently, Brucke made the same discovery in Germany, through the curious circumstance, that occasionally when looking through his spectacles, at the face of another, he saw his neighbour's eye glare like a cat's.

"The demonstrability of the proposition, that the eye is not a camera obscura, depends upon the fact, that when rays of light enter the eye, and fall upon its back wall, as many of them as are reflected from the retina, or from the choroid behind it, will exactly retrace their course, and pass out through the pupil to the luminous body or illuminated object from which they came. Thus the diverging rays of a gas-flame are converged by the refracting media of the eye, to a focus upon the retina, where they unite to produce a picture, and thereafter in great part traverse that membrane and fall upon the choroid. If from either of these membranes rays are reflected (and for the sake of simplicity, we may, for the present, limit ourselves to the retina, which is the more powerful reflector of the two), they will follow in a reversed direction, the very course which they took in reaching that membrane, and return to the gas-flame, producing there an image of the picture on the retina, so that the reflected image of the flame is placed upon, and coincides in size and position with the actual flame.

* Transactions of the Royal Society of Edinburgh, Vol. XXI., Part II.

To see, therefore, into the deeper chambers of a living eye, we must arrange matters so that we can look along the straight line of the reflected rays, without intercepting the light from which they originally came.

"The experiment is thus made:—'In a dark room, with a single flame at the side of the experimenters, and on a level with their eyes, the person whose eye is to be observed holds a piece of glass (a microscope glass slip), so as to catch the image of the flame on it; he then, by inclining the glass, brings the image of the flame opposite the pupil of the observer's eye; the latter will then see the pupil of the observed eye luminous, of a reddish-yellow bright colour. . . . . A person may also see one of his own pupils luminous: standing before a looking-glass, and seeing the image of the flame in the reflector with his *right* eye, let him bring this image opposite the pupil of the left eye in the looking-glass; the left eye will then perceive the right pupil in the mirror luminous.'"

Various German physiologists have invented instruments called ophthalmoscopes, for the purpose of viewing the reflected light from the retina. It appears, however, that the choroid as well as the retina is a reflector of light, and thus deprives the eye of the character of a camera obscura. Yet, notwithstanding these facts, which cannot fail to have been for some time noticed by physiologists, Dr. Wilson is not aware that any material alteration in the current theory of vision has been proposed by any writer. With respect to Albinos he observes:—

"It cannot then, I think, be questioned, that in those animals which exhibit the full development of long hereditary albinism, the sensitiveness of the retina to light has undergone a permanent abatement, whilst the iris has probably altered also in thickness and contractility. I venture to predict, that if ever an albino race of men shall be observed or developed, they will prove, after the lapse of a generation or two from their founders, to have eyes as serviceable as those of the majority of mankind.

"It is sufficient for my present purpose to point to the albino animals, whose eyes are totally destitute of pigment, and reflect light from every point of the surface, both of the retina and the choroid, but, nevertheless, exercise the faculty of sight in perfection. Their eyes, even when the iris is fully contracted, remain, in virtue of the transparency of that membrane, *cameræ lucidæ;* their possessors cannot render them *cameræ obscuræ;* and yet they are excellent organs of vision.

"If the reasoning pursued in reference to the albino eye be valid, it will serve also to dispose of the difficulty experienced by some in explaining how vision is compatible with the presence of a *tapetum lucidum* in the eyes of many animals. This tapetum is equivalent to a concave mirror of polished metal, replacing the pigment of the choroid over a greater or smaller part of its surface, especially at the deepest or most posterior portion of the chamber of the eye, so that lying behind the retina, it is more or less directly opposite the pupil, and receives the light which enters by it. A brilliant reflecting surface of this kind is found in many of the mammalia, both graminivorous and carnivorous, as the horse, the ox, the sheep, the cat, the dog. It is present in the eyes of the whale, seal, and other marine mammalia; and in fishes, such as the shark, in which it is peculiarly brilliant. It occurs also in certain of the mollusca, as the cuttle-fish; in certain insects, as the moths; but never, I believe, in birds. It is most largely developed in animals which are nocturnal in their habits, or live like fishes in a medium which is dimly illuminated. All must be familiar with the glare of light which it throws from the eye of the cat or dog, when these animals exhibit dilated pupils in twilight.

"This *tapetum lucidum*, has been a great stumbling block to physiologists. The albino eye was set aside as abnormal; and the reflection of light in normal eyes from the retina and choroid was overlooked, or regarded as accidental, but that from the tapetum could not be. Most writers, however, dismiss it with an unsatisfactory and very brief comment, unable evidently to reconcile its presence with the maintenance of that internal darkness of the eye, which is supposed to be essential to vision."

In presenting a resumé of the whole question, Dr. Wilson enumerates many curious facts relating to vision and its object, the following extracts furnish as condensed a view of this extremely interesting subject as we feel warranted in giving:

It thus appears that the laws of luminous reflection do not necessitate imperfect vision, as applied to the fact, that the retina and choroid return much of the light which reaches them, for:—

1*st.* In the normal and also in the albino vision of all animals, man included, the amount of direct retinal and choroidal reflection is necessarily coincident with the width or degree of dilatation of the pupil; the larger the pencil of light entering the pupil, the larger the pencil leaving it, so that in every case the reflected rays are thrown out of the eye and do not disturb vision: further,—

2*nd.* In those animals provided with *tapeta lucida*, such as the cat, the dog, or the ox, which are only partially nocturnal in their habits, the tapetum is so placed that in bright light it is not opposite to the contracted pupil, or is so only to a small degree. When, however, the choroidal mirror is called into action in twilight, the pupil is correspondingly dilated, and all the light which the tapetum reflects finds a free passage for its escape.

3*d.* In the eye of man, as well as in that of a large number of other animals, the background of retina and choroid on which the image is depicted, is not the darkest portion of the ocular screen, nor even so dark as those parts of the inner walls of the eye on which objects are never figured. On the other hand, as John Hunter has shown, and illustrated by existing specimens, the front and the anterior sides of the eye-chamber are the darkest, so that the reflecting power is greatest at the bottom of the eye.

4*th.* In the human eye, where, more than in those of the lower animals, it has been contended that the conditions of a camera obscura must be realised, the place of perfect vision, instead of being additionally darkened, is occupied by the well-known *yellow spot*, which has a marked reflective power, and is easily discerned by ophthalmoscopes.

The results which are announced in the preceding argument may be summed up as follows:—

1. The total absence of pigment from the choroid, the ciliary processes and the iris is compatible (especially where this condition is hereditary) with perfect vision.

2. The replacement of the pigment of the choroid lining the bottom of the eye by a concave mirror (*tapetum lucidum*) powerfully reflecting light, characterizes animals whose vision is very acute.

3. The non-tapetal or mirrorless eye of man, and of many animals, differs only in degree from the tapetal or mirrored eye of others; for the retina and choroid act as a tapetum, and reflect light in the same way.

4. The eyes of vertebrate animals are only to a limited extent *cameræ obscuræ*, and internally are least dark in the portions most directly exposed to the action of light, and where the seat of perfect vision is placed.

5. The back of the iris, over which the retina does not pass, is the darkest internal portion of the eye in vertebrates; and next to it, in the majority of these, are the ciliary processes of the choroid, and its anterior lateral portions.

From these premises the conclusion is deducible that in vertebrates much light is reflected from the bottom of the eye-chamber during the exercise of vision without disturbing it; but that little is reflected again, so as to return to the bottom of the eye, in consequence partly of its absorption by the pigment of the anterior portions of the choroid, partly of its escape through the pupil.

It may seem to some that this reasoning proves too much, for why is there in man and many other animals a pigment at the bottom of the eye, if reflection from the membrane there is so free to take place? To this I reply that the pigment, which is never altogether inoperative, comes into special action when the eye is exposed to very bright light, and saves the retina from the paralyzing influence of intensely luminous rays. Vision, however, cannot be continuously exercised under such exposure, even where the light is not excessively brilliant, in consequence of the instinctive closure of the eyelids, and the abundant secretion of tears which then take place. The pigment at the bottom of the eye is thus, I apprehend, a safeguard against sudden exposure to intense light; but during continuous vision under an illumination which does not dazzle the eye, its action is secondary as an absorber of light, and it always acts as a reflector.

Hitherto I have been arguing almost solely for the negative conclusion, that the vertebrate, and especially the human eye, is not the kind of darkened chamber which it has been supposed to be. It is impossible, however, to regard the deep intra-ocular reflection which so certainly occurs in most animals, as an incidental or useless phenomenon. That it has a direct and beneficial influence over vision I cannot doubt, and I proceed briefly to indicate where the proof of this is to be found.

Intra-ocular reflection, as a normal phenomenon, is at a maximum in the tapetal or mirrored eye of the lower animals. It is desirable, accordingly, to study it first as occurring in them; nor can a better example of a mirrored eye be found than that presented by the shark. In it the *tapetum lucidum* occupies the whole of the bottom, and one-half or more of the lateral surface of the choroid, which is covered by pigment only in front. The iris, as in other fishes, is incontractile, so that the diameter of the pupil never varies; and the tapetum, which is colourless and very brilliant, is thus always in action as a reflector. The shark, however, swims near the surface of the sea, where the amount of light is considerable, and the acuteness of its vision is proverbial. I have selected it, rather than a mammal, with eyelids and a contractile iris, because in the shark luminous reflection never ceases unless in absolute darkness; and when light is shining occurs the more, the brighter the light is. Its eye is thus always in the condition in which that of a cat, or dog, or ox is, when subdued light causes the iris to expand, and allows the reflecting tapetum to come into play, so that the considerations which I have to urge apply to the mammal as much as to the fish, provided they are taken with pupils equally dilated; but as the tapetum in the shark is very large, very brilliant, and always in action, I shall restrict myself for the present to it.

The light, which penetrates to the bottom of a shark's eye, will, in part, be reflected from the retina (a phenomenon which for the present I disregard), in part traverse it, and reach the tapetum, where a portion will be lost by absorption and irregular reflection or dispersion, and (what alone concerns us here) in part undergo direct reflection, return through the retina, and escape by the pupil. This returned light will impress the retina in traversing it, and illuminate external objects on leaving the eye.

The first question, then, is, "How will this light impress the retina?" According to J. Müller and W. Mackenzie, as we have already seen, only injuriously, so far as freedom from the sensation of dazzling, or distinctness of visual perception, are concerned; according to Todd and Bowman "probably" by "increasing the visual power, particularly when the quantity of light admitted into the eye is small." I have urged elsewhere that "what is equivalent to two rays of light falling upon the retina will produce two impressions. We send a capillary sunbeam through the retina in one direction, and instantly return it through that membrane, a little diminished in intensity, in the opposite direction; if it determined a sensation in its first passage, what is there to prevent its doing so in its second? If, for simplicity's sake, we suppose exactly the same points of the retina to be traversed by the incident and the reflected ray, then (unless the luminous intensity of the incident ray was so great as by its passage to exhaust the sensibility of the retina), the reflected ray will repeat somewhat less powerfully the impression made by the incident one. The difference will be as great as there is between a sound and its echo, but not greater.

On this view of matters, the tapetum, especially in twilight, will serve the important purpose of making every perceived ray of light *tell twice* upon the retina, so that the sensation it produces will either be increased in distinctness or in duration, and probably in both.

I will not deny that we are not entitled at once to infer that because a molecular change (modulation, vibration, polarization?) transmitted through a special structure in *one* direction produces a peculiar sensation, it will certainly produce the same sensation on being transmitted through that structure in the *opposite* direction; but there are strong analogies in favour of such a view, and it is entitled to be regarded as a likely hypothesis

The first probable use of the tapetum, then, is to double the impression which light produces upon the retina, whilst that light is within the eye.

The greater part of this light, however, after traversing the retina with little diminution by absorption, passes outwards through the pupil, and, along with the light reflected from the retina, is thrown upon external objects, and illuminates them. A singular reluctance has been shown by physiologists, especially in recent times, to acknowledge this. The supposed necessity of maintaining the chamber of the eye dark, the apparent impossibility of the eye reflecting and receiving light simultaneously, and the faintness of the light emitted from tapetal eyes, have led most writers to contemn the doctrine that the tapetum is a serviceable reflector of light. But the objections to this doctrine are in reality of no value, and were not entertained by the older writers, such as Hunter and Monro, who not only regarded the tapetum as casting light on external objects, but, in the case of graminivorous animals, as affording them, by the green colour of the light which is reflected, an assistance in discovering their food; an opinion which Cuvier in part countenances.

As I have discussed this question at length elsewhere, I shall merely observe here that as the light emitted from a cat's or a shark's eye, *ex. gr.*, is veritable light, there is no room for affirming that its illuminating powers are not, *cæteris paribus*, equal to light of the same quality from any other source. If we can see a cat in the apparent darkness, which otherwise would render it invisible, by the light which issues from its eyes, it cannot be questioned that it will see us by so much of that light as our persons reflect back into those eyes. The *tapetum lucidum* is, for every creature which possesses it, a lantern, by which it can guide itself in the dimmest twilight, and make each ray of light do double or triple service, in assisting it to steer its course, and to find its food or prey.

But if the tapetum assists carnivorous animals in finding their living prey, it must also give the latter warning of the approach of the destroyer. I am not aware that this use of the tapetum has hitherto attracted attention. But a lion or a shark does not more certainly bring into view, by means of tapetal light, the creature it would devour, than it betrays its own presence to that creature, and the balance is thus mercifully maintained between the preyer and the prey. That singular "hypnotising" or "mesmerising" power which, in the case of the serpent, is called "fascination," is probably largely possessed by the glaring tapetal eye, which acts with all the advantage of surrounding darkness to increase its impressiveness, and prevent other objects from distracting the attention of the subject of fascination. On the other hand, however, the tapetal light is peculiarly startling to an observer, for it is always coloured and unlike that of day, resembling in character (in the case at least of the cat and the dog) those fluorescent rays of the spectrum, which Mr. Stokes describes as "ghostly," and of which it probably largely consists. At all events, its unfamiliar appearance specially qualifies it to alarm creatures who suddenly perceive it, and are led by instinct to flee from all strange lights.

In the lower animals, then, the tapetum is probable serviceable—

1°. By doubling within the eye the impression of each ray upon the retina.

2°. By reflecting light from the eye upon external objects, so as to render food or prey more visible.

3°. By warning, through the agency of that light, creatures on which carnivorous animals prey, of the neighbourhood of their enemies.

In the discharge of those functions the retina more or less conspires, differing from the tapetum chiefly in reflecting a less coloured light than the latter does. Further, in such of the lower animals as have not tapeta, there must occur in most, alike from the choroid and the retina, and in all at least from the retina, reflection of light. In those whose eyes exhibit choroidal reflection, the same good ends will be served by it, though in a much less degree, as are secured by tapetal reflection, and of these probably the most important is the first, which cannot be attained with light reflected from the retina.

How far human wisdom is *sensibly* influenced by the choroido-retinal reflection which is continually occurring within the living eye, it is difficult to decide; but it must be influenced to some extent by it. It seems probable that the acute vision in faint light which characterizes those who are imprisoned in dark chambers, and which the astronomer sometimes purposely induces by long shading of his eyes before making observations, is in part due to the return of light from the choroid through the retina; in part to the passage through the highly-dilated pupil of light reflected both from the choroid and retina, which is thrown upon external objects. It may startle us at first to be told that we see in part by light issuing from our eyes, but it must be so; and those traditions of learned men who could read by the light of their own eyes in what was darkness to others, are only exaggerations of a power more or less exercised by every human organ of vision.

To one result of this choroido-retinal reflection in the human eye, I would, in conclusion, refer. The light which is thus reflected, is always *coloured*, being, as we have already seen, red, yellowish-red, or brownish-red, and differing necessarily in its tint, according to the abundance of pigment in different eyes. Each of us thus adds to every object on which he looks so much *colour*, but no two pairs of eyes the same amount, and hence one great reason why no two persons, almost, will be found to agree as to the matching of one colour with another where the coloured substances compared consist of different materials; and why very marked differences present themselves in the judgments of persons equally practised in observing and copying colours.

Two artists, for example, paint from nature the same flower. The pigments which they employ for this purpose, will, of course, be as much affected by the colour communicated from the eye, as the flower is, so that, could the latter be imitated in its own materials, the copies might be identical. But as these must be made with substances whose lustre, transparency, and particular tint, differ from those of the body copied, the added colour from the eye tells unequally on the original and the copy, as compared together, and as seen by different eyes. Each, accordingly, objects to the other's colouring, but neither can induce his neighbour to adopt his tints, and both appeal confidently to third parties (who perhaps differ from both), assured that the adjudication will be in favour of the appellant. Here each may have been equally skilful and equally faithful: and neither has any means of testing to what extent he sees everything as if through coloured spectacles, which give all objects a tint for him inseparable from their natural colour. A "chromatic equation," thus originated, belongs, I believe, to every eye.

P.S.—From my friend Professor Goodsir, who recently (June 27th) delivered a lecture of great interest and originality on the retina to the anatomical students of the University of Edinburgh, I learn that, from the observations and speculations of the Continental Physiologists, it appears very probable that *only* the rays of light which are returned from behind through the retina produce a luminous sensation, and that the objective perception of light commences physically at the choroidal, not the hyaloid extremity of the optically sensific constituents of the retina. According to Kölliker, this objective perception begins at the extremities of the rods and bulbs which are in contact with the pigment of the choroid,—a view of matters not readily reconcilable with the organization of the *yellow spot*, where vision is most perfect; according to Brücke, luminous sensation begins in a layer of gray nervous substance, situated nearer the front of the retina; but both observers agree in ascribing entirely to that light, which is passing back from the choroid, the power of initiating luminous perceptions. I have argued, in the preceding paper, for such returned light being *accessory* to vision, but according to this view it is the only light by which it is exercised. If this doctrine (however modified in details) be established, the reflection of light from the choroid will prove to be *essential* to the function of seeing, and the necessity for the living eye being a Camera Lucida, will be based upon deeper grounds of proof than I have attempted to offer.

The Prize Essays.

1.—CANADA; AN ESSAY—*To which was awarded the First Prize by the Paris Exhibition Committee of Canada.* By J. SHERIDAN HOGAN. John Lovell, Montreal.

2.—CANADA AND HER RESOURCES;—*An Essay, to which was awarded the Second Prize by the Paris Exhibition Committee of Canada.* By ALEXANDER MORRIS, A.M., Barrister at Law. John Lovell, Montreal.

3.—CANADA: PHYSICAL, ECONOMIC, AND SOCIAL. By A. LILLIE, D.D. Maclear & Co., Toronto.

On the 13th November, 1854, the Executive Committee of the Paris Exhibition issued an advertisement announcing their intention of offering for public competition three prizes for the best three essays on "Canada, and its resources; its geological structure, geographical features, natural products, manufactures, commerce, social, educational, and political institutions, and general statistics." Practical utility and comprehensiveness, combined with conciseness, were to be among the chief considerations on which the awards of the judges would be based. The Essays were to be sent to the Secretary of the Executive Committee on the 15th February, 1855, thus allowing exactly ninety-two days, or three months, for the production of a work on Canada embracing a comprehensive description of the physical and social condition of the country.

No one, we suppose, who takes the trouble to consider the nature and extent of the subjects suggested by the Committee, can fail to be convinced that the time allowed was much too short. Indeed, as the period for the reception of the Essays drew to a close, the Executive Committee appear to have become convinced of the necessity of extending the time as much as lay in their power, and accordingly they added fifteen days to the three months before granted.

The opportunities thus afforded for obtaining literary distinction were, however, sufficiently enticing to bring into the field no less than nineteen competitors for the honours and emolument offered by Government. Of the essays subjected to the consideration of the judges, three were reported "prizeworthy," three received honorable mention, one was passed over as illegibly written, and twelve remain in the hands of the Assistant Secretary of the Committee, from whom they may be obtained by the authors. The judges being unable to decide upon the order in which the three essays reported prizeworthy should stand, requested his Excellency the Governor General to make the award. No more capable or disinterested judge could have been selected, or one from whose expressed opinion disappointed competitors or their friends would feel inclined to appeal; and after a careful perusal of the two competing essays which are named at the commencement of this article, we do not hesitate to avow our conviction of the justice of that award. We do not wish it to be understood, however, that *any* one of the essays before us presents a complete picture of Canada; it is not to be supposed that the short period of fourteen weeks would embrace time enough for any writer, however familiar with its physical history and its social condition, to describe the country, its resources and its people with minuteness and detail. The evident object of the Executive Committee of the Paris Exhibition was to obtain a readable account and description of Canada and its institutions, in order to place in the hands of the middle classes in Europe a popular exposition of what we offer here to industry and enterprise. Mr. Hogan has furnished us with such an essay, which, though certainly not free from sins of omission and a sprinkling of errors, is capable of creating a very interesting, encouraging and truthful impression of many leading features in Canadian life, and of the encouraging future which lies within the reach of every immigrant, and is the sure destiny of the country at large. In the introductory chapter to Mr. Hogan's essay, we find especial allusion made to the class of people for whose information and guidance the essay was, with judicious care, more particularly written. After alluding to the significant facts, that the population of Western Canada in 1829 was only 190,000, and the value of the real and personal estate of the people estimated at £25,000,000, that, in 1854 the number of its inhabitants had swollen to 1,237,600, and its assessed and assessable property to £50,000,000, Mr. Hogan asks:—

"And who and what are the people who divide among them this magnificent property? And how have they acquired it? Did they come in as conquerors, and appropriate to themselves the wealth of others?—They came in but to subdue a wilderness, and have reversed the laws of conquest; for plenty, good neighbourhood, and civilization mark their footsteps. Or did capitalists accompany them, to reproduce their wealth by applying it to the enterprises and improvements of a new country? No;—for capitalists wait till their pioneer, industry, first makes his report, and it is but now that they are studying the interesting one from Canada. Or did the generosity of European Princes, or European wealth or benevolence provide them with such outfits as secured their success? On the contrary, the wrongs of Princes, and the poverty of Nations, have been the chief causes of the settlement of America. Her prosperity is the offspring of European hopelessness. Her high position in the world is the result of the sublime efforts of despair. And he who would learn who they are who divide among them the splendid property created in Canada has but to go to the quays of Liverpool, of Dublin, of Glasgow, and of Hamburg, and see emigrants there embarking, who knew neither progress nor hopes where they were born, to satisfy himself to the fullest."

The description of the geographical features of the country is very general, and in some instances unnecessarily so, for we find no reference made, even in name, to the rivers, Thames and Grand River, which unwater the richest and most fertile portion of the Western Province. The chapter devoted to the "Geological features and soil" of the country is occasionally obscure, and not without mistakes, which, with a little reflection and care, might have been avoided. "All the great lakes are placed in the line of contact between two vast chains of Granite and Limestone." How does this general statement apply to Lake Ontario and Lake Erie, the lakes *par excellence* of Canada. The Granite is met with at the eastern extremity of Lake Ontario, and the lake itself is excavated wholly out of unaltered Lower and Upper Silurian rocks. Lake Erie is excavated entirely out of Upper Silurian and Devonian rocks, and in no part is less than 200 miles from granite exposures. The observation is partially correct with regard to Lakes Huron and Superior, the least important of Canadian lakes. Again, "From Quebec to Niagara the red slate [?] is perhaps the prevailing rock," and in the very next line, "the subsoil around Lake Ontario is limestone on granite." . . . . "On Lake Erie the strata are limestone, slate [?] and sandstone." These contradictions and errors acquire importance in Canada where the real facts are locally known, because they leave room for cavil and ungenerous criticism, and may affect the value of the essay and the interests it is well designed to subserve.

The chapter describing the struggles and hopes of the early settler of Upper Canada is a truthful picture; the one which follows it, portraying the farmer of Upper Canada as distinguished from the early settler, is also well drawn and very encouraging:—

"Were I asked what is the leading characteristic of the Upper Canadian farmer, I should unquestionably answer, PLENTY. Plenty reigns in his granary, plenty is exhibited in his farm yard, plenty gleams from his corn fields, and plenty smiles in the faces of his children. But let it not be imagined that this plenty is gained without continuous labour, and the exercise of judgment and intelligence. Many of the finest farms in Upper Canada have passed out of the hands of those whose fathers won them from the forest; and many more are exhausted and unproductive, through injudicious management, indolence, or inattention; and in some instances the very labourers on the farms which have been sold and wasted by the second generation, have been able to purchase them. Industry literally converted the labourer into the lord, whilst extravagance and indolence reduced the lord to the labourer."

Canada contains a population at the present moment exceeding two and a quarter millions, and, as Mr. Hogan justly remarks :—

"There is perhaps no part of the world known to modern history, with the exception of California and Australia, where a greater increase has taken place in the population. In the latter countries the discovery of gold has imparted an unnatural stimulant to settlement; but in these places, unfortunately, the chief things which labour leaves to mark its footsteps are unsightly cuttings and mounds,—the monuments too often of hardships without rewards, and bitterly disappointed hopes. But in Canada labour is marked by corn fields, which contribute to the riches and comforts of the whole world; and success is of that character, that it raises man by its example, and makes whole races respectable."

The chapters on manufactures and ship-building; trade and commerce; revenue and expenditure; banks; inducements to emigrants; wages; and price of land, are sufficiently amplified to afford a general idea of a rapidly growing commerce, and a condition of progress and prosperity which is only paralleled by the States of the Union in the region of the Great Lakes. It is a favourable feature in the financial condition of Canada, that the bugbear taxation presses so lightly upon the farmer. Perhaps no country in the world is more free from this incubus than Canada with reference to the country at large, and it is a matter of individual regret to every one interested, that the same remark does not apply to our cities and towns, many of which are beginning to acquire an unenviable notoriety for the rapid increase of this objectionable burden :

"From a table recently compiled in England it appears that the sum contributed by the inhabitants of Canada to the revenue is considerably less than that contributed by any other British Colony. The inhabitants of the Australian Colonies contribute two pounds per head, the West India Islands one pound, and the other British North American Provinces ten shillings. Canada contributes eight shillings and two pence. The revenue for 1854 is estimated at £1,423,520, and the expenditure at £939,595, or at the rate of 8s. 2d. for each inhabitant. The Boston Almanac gives the expenditure of the United States at £12,939,876, which, divided into the population, makes 11s. 1d. per individual, or thirty-seven per cent. higher than the indirect taxes of Canada; but this includes 3,204,067 slaves, or nearly one-seventh of the whole population, who are not taxed; deducting these it would add fifteen per cent. per individual to the tax on the free inhabitants of the States."

A long and interesting chapter is devoted to the subject of "Internal Communication," it has evidently been hastily written, and requires a few corrections and additions, which may generally be effected by the introduction of a letter or a word, as in the following extract :—

"The remaining link of canal—for I may as well speak of it in this connection—between the Gulf of St. Lawrence and the head of Lake Superior, is the Welland, which unites Lakes Erie and Ontario, and avoids the Falls of Niagara. Its locks are little less capacious than those on the St. Lawrence Canals, but are equally well built. They have chambers a hundred and fifty feet long, by twenty-six and a-half feet wide, and the available depth of water in both is between nine and ten feet."

The Sault St. Marie Canal, which unites Lakes Huron and Superior has been overlooked,—its locks have chambers 350 feet long and 70 feet in width.

Mr. Hogan's views of the importance of the River St. Lawrence, and of the magnitude of that commerce of which it is destined to become the uninterrupted highway, are fully and eloquently expressed. The following extract will show that he entertains decided views respecting the future of our noble river :—

"The first thing that strikes one, in contemplating it, is its adaptation, in point of immensity, to the vast regions it waters. Whilst the business necessities of the West, and those portions of America which are universally admitted to be, both by their relative position to other rivers and to it, its natural feeders, have literally shamed the enterprises that were intended to provide for them, its magnitude and its value are being but discovered by the contrast. The Erie Canal, highly valuable as a work, and successful beyond comparison, *has been made little by progress*. The St. Lawrence, on the contrary, only requires enormous use to test its greatness. It is impossible, indeed, to contemplate this river, in connection with the canal which was made to rival it, without being struck with the inadequacy of the one and the amplitude of the other.

"The valleys and plains watered by the St. Lawrence, being largely in the United States, have chiefly contributed to the Erie Canal's business. Their fruits were literally wooed away from their natural channel to minister to its prosperity. The St. Lawrence, in so far as American policy, and great restrictions upon commerce, could affect it, has been sacrificed to the Erie Canal. Nature's outlet had navigation laws, which drove commerce away from it, to contend against. The Erie Canal had all these disadvantages to the river converted into so many advantages in its favor. Yet the laws of progress, which have swept away the obnoxious navigation restrictions, have, at the same time, established the failure of the Erie Canal. Not that it is unprosperous as an enterprise, nor that, as a *local work*, it is not unsurpassed as a speculation, but that, for the great purposes of its construction, namely, to convey to the ocean the fruits and productions of the West and North-west, it is emphatically a failure,—*because progress has completely over-burthened it; it is literally surfeited by its own prosperity*. And it matters not to him,—an individual, in such a case, being the nation,—who has boards or flour to send eastward by it, whether they are stopped by reason of starvation, or because of a surfeit. The impediment to his business is the all-important question with him. And though the Erie Canal paid larger profits than any other work in the world, yet, in a national point of view, if it afforded not adequate facilities for business, or stopped it in its course, it might, by drawing to it what it could not do, be the means of wide-spread evil, instead of general good. And that this is, to a great extent, the present position of the Erie Canal, is universally admitted.

"To obviate these difficulties, enterprise has again undertaken to swell its dimensions to meet the enormous demands of *progress*. But in view of the vast regions which are common alike to it and the St. Lawrence, and which are as yet but in the infancy of their population and business, is it not probable; nay, is it not certain, judging by the past, that twenty years hence will find the Erie Canal again choked up with business; again *made little by progress?* When the magnificent tracts of country embraced in Michigan, Wisconsin, the northern portions of Ohio and Indiana, Illinois, Iowa, Minnesota, and the west and north-western portions of the State of New York, which now wholly or largely use the Erie Canal as a highway to the ocean, come to be settled up, and to have, instead of some five or six millions of inhabitants, at least eighteen or twenty, what *mere canal*, with its hundred locks, and its hundred other impediments, will be equal to their vast business necessities? will be in keeping with their splendid progress? will satisfy their craving for rapidity, magnitude, and commercial convenience? Will not the Erie Canal *then*, enlarged though it be, be but another added to the numerous examples in America *of progress utterly distancing enterprise, and prosperity shaming the calculations even of talent?*"

The remaining chapters are devoted to the enterprise of Canada in relation to Railroads; their value and importance; their intent, construction, and routes. The Municipal System of Upper Canada; the Government of Canada and its future. We shall conclude our notice of Mr. Hogan's excellent essay with a few of its closing paragraphs—and the expression of a hope that an opportunity will soon be offered of avoiding, in a second edition, those inaccuracies and omissions, which are clearly traceable to the hurry in which the essay was prepared:

"The people, I may say, of all North America—I mean the descendants of the British race, and emigrants from Britain—are, perhaps, of all others the best trained to understand and to enjoy the benefits of representative institutions. Their habits of self-reliance and the *necessity for combination to effect the simple purposes of existence*—to build the log hut far in the woods; to "log" the first acres of ground cleared; to throw a bridge over a stream, or to clear a road into the forest,—naturally lead them to respect skill, and to put themselves under the guidance of talent. The leading spirit of a "*logging bee*," and the genius who presides over the construction of a barn, what more natural than that they should be elected, at the annual meeting of the neighbourhood, to oversee the construction of bridges, and to judge of, and inspect, the proper height of fences? And this is the first legislation such a people have to do. The useful individual, too, in a settlement, who draws deeds and wills, and settles disputes without law, and gives good advice without cost, what more natural, also, than that he should be selected by the people he benefits by his education and his kindness, to make their laws, and to guard their interests? The Canadian people, too, have no tenant rights, nor "trades unions" to secure higher wages, or to prevent too many hours work. Their necessities are their orators. Their ways and means of living, and taking the best care of what their labour brings them, are the principles by which they are governed. Their democracy begins at the right end; for, instead of weaving theories to control the property of others, they think of but the best means of taking care of their own. Need it be wondered at, then, that a people so educated—and such has been the universal education of North America—should know how to govern themselves; should gradually rise from the consideration of the affairs of a neighbourhood to those of a county and of a country; that they should have sufficient conservatism to guard the fruits of their industry, and sufficient democracy to insist upon the right to do so. And such is a true picture of the Canadian people. Their municipal system is but a small remove from the leader of the "*logging bee*" being elected builder of the bridge, and their parliament is but a higher class in the same school of practical self-government. Their being given in fact the entire control of their own affairs was but removing expert seamen into a larger ship; and Great Britain has but to consider, in dealing with her other colonies, that the ship is always adapted to the sailors. For, the understanding a people is of infinitely greater importance, in giving them a constitution, than the understanding ever so well abstract principles of government."

We now proceed to examine the essay by Mr. Alexander Morris, A.M., to which was awarded the second prize. Mr. Morris in his preface "disclaims all pretension to originality," and tells us that "his labour has been the plodding one of a compiler." This essay is about one-fourth longer than Mr. Hogan's, and embraces copious extracts from the admirable reports of Messrs. Logan and Murray; the first chapter, referring to the geological structure of Canada, being condensed from the Report of Progress for the year 1843. The descriptions of the geographical features of the Ottawa Region and of the Eastern Townships, are very full and complete, and in general, the geography of Canada is given with considerable minuteness of detail.

Mr. Morris has, however, succeeded in disarming criticism, by limiting himself strictly to the duties of a compiler, without entering into any speculations or descriptions, which give a charm to Mr. Hogan's essay, and contribute so much to make it a readable book. Indeed the second prize essay may be described as a condensed series of miniature Blue Books, in which the chief facts relating to the products of the forest, the mines and fisheries, agricultural produce, manufactures, and commerce, are given with considerable precision and in the plainest language. The chapters on social institutions, educational institutions, political institutions, and statistics, while containing a very large amount of information, are evidently written by a gentleman whose form of thought and style of expression have been influenced by the study of a rigid profession, which of all others is least susceptible of adding a charm to the description of social progress, or interest to the dry enumeration of political and commercial triumphs. Mr. Morris's professional position enables him to write with advantage on the political affairs of Canada:—

"The Government of the Province is conducted by a Governor General, appointed by the Crown, who presides at the deliberations of an Executive Council nominated by the Crown, but who must, according to the theory of Responsible Government, in practical force in Canada, possess the confidence of the people, as evinced by a majority of the House of Assembly; and who, consequently, may lose their places on a vote of want of confidence. The Executive Council is composed of the following officials, viz.: a President of the Committees of the Council (who is also Chairman of the Bureau of Agriculture, and of the Board of Registration and Statistics;) a Provincial Secretary, an Inspector General, a Commissioner of Crown Lands, a Receiver General, one Attorney and one Solicitor General, one of each for each section of the Province; a Commissioner of the Board of Public Works, and a Postmaster General. These incumbents preside over the public departments indicated by their titles, in addition to exercising the functions of Executive Councillors. On the acceptance of office, the incumbent elect, unless a Legislative Councillor, must present himself to the people for re-election. The Solicitors General are not necessarily Members of the Cabinet.

"Such is the system of governing by Legislative majorities and responsibility to the electors, which is in force in Canada. Practically the Government of the Province is self-government, the British Government rarely interposing the weight of its authority, but, on the contrary, distinctly enunciating its desire to allow the Province the widest latitude in self-government, compatible with the Colonial relation. In fact, the Canadas enjoy the largest measure of political liberty possessed by any country or people. The public offices, and the seats in the Legislature, are practically open to all. The people, by their representatives in Parliament, regulate all matters of Provincial interest, and by their municipal system they regulate their municipal matters, while they possess and exercise the power of rejecting at the polls those who have forfeited their confidence. The inhabitants of Canada are bound to Britain by the ties of common interest, common origin, and filial attachment. Owing a grateful allegiance to their Sovereign, they are proud to share the heritage of Britain's ancestral glories, while they are not slow in evincing their sympathy with her struggles, as the magnificent grant of £20,000 sterling, gracefully appropriated by the Legislature to the Patriotic Fund, and to the widows and orphans of the soldiers of her ally, France, proudly shews. The policy of Britain is a wise one. She is building up, on the broad foundations of a sound political liberty, freedom of thought and conscience, a colony which will one day, (though the connection will never be rudely severed,) attain the position of a nation, and peopled by inhabitants knit to Britain by the strongest ties of blood, and identity of feeling, will strengthen her hands and support her position by the reflex influence of sound, national and constitutional sentiment.

"The future of Canada is a brilliant one: a great problem is being wrought out in her history; and, on review of her immense resources, and on a glance at her hardy, self-reliant population, the mind is irresistably urged to the conclusion that her destiny is a grand one, and that, on this American continent, she may yet be destined to play no insignificant part among the role of people."

Dr. Lillie's essay, entitled "Canada—Physical, Economic and Social," was passed by unread, "on the alleged ground of the illegibleness of the manuscript;" the author has therefore assumed the responsibility of its publication, partly on account of the fact of his having written being generally known, and partly in the hope of diffusing information respecting Canada. Dr. Lillie's essay is more than double the size of Mr. Hogan's, and considerably exceeds that of Mr. Morris,—it contains nearly 294 pages of printed matter, together with two excellent Maps, one of Upper Canada and the other of Lower Canada. The essay is divided into three parts, as its title implies. One hundred and thirty pages are devoted to the physical description of the country, the subject of geology forming by far the most important and extensive of this division. One hundred and seven pages are devoted to the economical history of Canada, and the remaining portion of the work, embracing fifty-five pages, is occupied with a narration of the social position of the inhabitants of the country. The absence of a good, copious index is much to be regretted. Dr. Lillie has shown an extraordinary degree of industry in preparing this essay for competition; and the number and diversified character of the authors he quotes, testify to the large amount of literary labour he has bestowed upon the comprehensive subjects of which he treats. Here again we have to regret the shortness of the time which was allowed to competitors. We do not hesitate to say, that several startling discrepancies which occur in the first part of Dr. Lillie's work would have been avoided, if the subject had been leisurely, instead of hastily, treated. It is also extremely probable that if more time had been allowed, the author would have seen cogent reasons for rejecting certain authorities he has advanced, and for bringing into more harmonious form the disjointed descriptions of the geological structure of the Province, which, in their present shape, will we fear, sadly puzzle even an "intelligent stranger." Take for example the statement on page 12 and compare it with the actual condition of things. "In New York and Canada it (the third division of the Lower Silurian) bears the name of Utica Slate and Hudson River Group. * * * Graptolites with fragments of Trilobites are the only fossils found in this division." The Hudson River Group, which extends from the Rouge to the Credit, and at very small depth immediately underlies the City of Toronto, is eminently fossiliferous, containing besides Graptolites and Trilobites, Corals, Fucoids and numerous genera and species of shells in vast abundance. On referring to Marcou's work we found that he had evidently misled our author, for Marcou says: "Fossils are rare in this division, the only ones are Graptolites, sometimes in great abundance, and fragments of Trilobites, especially the *Trinucleus Caractaci.*" An hour's inspection of the quarry opposite the parliament buildings, or of the rocks in the Humber river valley would have satisfied Dr Lillie of the value of M. Marcou as an authority. On page 13 we find the following: "Beds of Rock Salt are often found in America, in connection with the Upper Silurian." It is possible that the occurrence of salt springs may have given rise to this supposition, but we are not aware that any proof of so remarkable a phenomenon has ever been obtained in America. M. Marcou appears to be the authority in this instance also.

We are thus induced to direct attention to these discrepances as Dr. Lillie's has not only drawn largely from M. Marcou's work, but also made very copious extracts from the reports of Messrs. Logan and Murray, and adopted a style of descriptive narrative in scientific language, which removes the subject beyond the reach of the class of general readers. At pages 12 and 13 our author adopts M. Marcou's distribution of the rocks in Western Canada, simply styling them Lower Silurian, Upper Silurian, and Devonian, and from pages 58 to 64 he goes over the same ground, following Mr. Murray's classification, using the terms applied to the subordinate members of the rocks before named, without stating how widely Mr. Murray and M. Marcou differ in their classification, or in their enumeration of the fossil remains distinguishing them. This is to be regretted, and we venture to say that the object would have been better attained if Dr. Lillie had expressed in his own language a general view of the geological structure of the country, based upon the reports of the Canadian survey. We question whether Dr. Lillie is aware that of Marcou's classification of the mountain system in America—from which he has drawn to the extent of nearly four pages of his work—it has been said by a truly eminent geologist, "if we needed a parody on Elie DeBeaumont and his systems of mountains, we have it here."

The chapter on the soils of Canada East and West, consists chiefly of extracts from the report of Mr. Hunt. On the climate of Canada chiefly of abridgments of articles contained in this Journal, and the same may be said of the enumeration of the natural productions of the country.

The second portion of the essay before us consists of extracts from a great variety of sources and authorities. Numerous passages from Dr. Lillie's own pen cause us however to regret that he had not adhered more closely throughout to an original form of expression, rather than content himself with transcribing the precise words of his authority. Here is a graphic picture, far more interesting, impressive and useful to the general reader than half a dozen extracts from "authorities:"

"Canada is constantly outgrowing the descriptions which are being given of her. The picture which was correct a few years ago thus misleads, if, instead of being regarded as exhibiting what *was*, it is viewed as illustrative of what *is*. And so it will continue to be. Without the gift of prophecy, the production now of a work which shall be true to the facts of even half a dozen years hence is an impossibility. It is only by frequent revisal, bringing them up every few years to the state of things which has grown up since their first appearance, that the very best works can be made to possess a permanent value as sources of information. Thus it is that the works of Mr. Macgregor and Montgomery Martin make the approximation which they do to the present actual state of the country.

"By way of example, we shall present a few statements from the works of Talbot, who published in 1824; and of Buckingham, whose travels in America appeared so late as 1843.

"*Toronto, our inquirer will learn from the same authority,* (Talbot who published in 1824) should he consult him, contains 1335 inhabitants, with about 250 houses, many of which exhibit a very neat appearance. Its public buildings are a Protestant Episcopal Church, which is a plain timber building of tolerable size, with a steeple of the same material; a Roman Catholic chapel, not yet completed, which is of brick, and intended to be very magnificent; a Presbyterian and a Methodist meeting house; the Hospital, which he pronounces the most extensive public building in the Province, describing it, at the same time, as *showing a very respectable external appearance;* the Parliament House, and the residence of the Lieutenant General. As for its streets, which are regularly laid out, intersecting each other at right angles, but being in wet weather unhappily, if possible, muddier and dirtier than those of Kingston—only one of them is as yet finished.

"Lay down Talbot, and take up Buckingham's "Canada, Nova Scotia, and New Brunswick,"—bearing date London, 1843—and you will learn (p. 101) that the city of which you have been reading has advanced so far as to have 13,000 inhabitants, with over 200 brick buildings, and nine newspapers, chiefly weekly, some twice, and some thrice, but none daily. So soon as you have got over your surprise at this prodigious growth, look into Tremenheere, if you can lay your hand upon it, and he will tell you, on the authority of the last census, that the population of Toronto amounted, in 1851, or rather beginning of 1852, to 30,763. At last you feel that you have got at the truth; the truth you have got certainly as to January or February, 1852; but this is January 1855. The population now, according to information received by me at the Chamberlain's office, is somewhere in the neighbourhood of 45,000. In 1851, the estimated value of property, real and personal, was £2,116,400; the assessed value (calculated at six per cent. on the estimated) £186,983 5s. Last year the assessed value amounted to £226,500 real, with £64,450 personal—in all, £290,950; and the estimated to £3,775,000 real, with £1,110,000 personal—making together, £4,885,000."

The third part of this essay is devoted to the social condition of the people of Canada, and like the preceding divisions, contains an immense amount of information, chiefly in the form of quotations. In taking leave of Dr. Lillie's essay we confess to two regrets, one being that a work containing so much valuable information, and giving evidence of considerable industry and application in its production should, by any alleged defect in the manuscript, have been passed unnoticed by the judges;

the other—before expressed—that Dr. Lillie should have "lessened the attraction of his production by taking away from it the air of originality which it might with much less labour than has been bestowed upon it have been made to wear," by a too rigid adherence to quotations from different authorities, while their views and facts might, in many instances, have been presented quite as truthfuly, and far more impressively, in a simple narrative form, similar to the original paragraphs which are interspersed throughout the work.

Vermes in Grasshoppers.

Early in September last I visited a brother Entomologist, who resides in Montreal, and my stay having been limited to one week I resolved to make good use of my time; therefore, the forenoons were devoted to collecting insects, and on a few occasions in the evenings, I accompanied my friend in his boat to the Rapids opposite the city, where we fished. The bait generally used for still-fishing are grasshoppers, freshly collected and kept in a bottle. On one occasion I selected a specimen measuring about 14 lines (probably an *Œdipoda*), found commonly on the island of St. Hellens. It had been a short time in the water, and I had indication of a "nibble;" shortly afterwards, on examing the bait, the posterior part of its body had been bitten off, and something protruded, having a resemblance to white thread, and which, at first sight, I took *to be its intestines. I disengaged the thread-like substance*, and discovered it to be an *intestina* measuring at least *nineteen* inches in length.

From one grasshopper two vermes were taken, and three from another; the latter were longitudinally coiled, and occupied the whole of the insect's body.

One of the oarsmen informed me that the grasshoppers which he kept in the bottle, since our previous evening's fishing, were dead on the following morning, and that a large quantity of vermes lay at the bottom—evidence enough to exhibit a common disease in this species of Orthoptera.

Judging from its form and length, I take it to be a species of *Echinorhynchus*—a type chiefly infesting the higher orders of animals, and am led to think, have not been hitherto found in insects. They are cylindrical, without joints, with a sharp-pointed retractile proboscis.

Should students of Helminthology, or Microscopists wish to examine them, they can be seen at the Museum of the Canadian Institute.

Toronto, October, 1855. WM. COUPER.

Parasites in the Bat.

Detroit, 15th Sept., 1855.

In dissecting a small bat, a few days ago, my attention was directed to some round spots of inconceivable minuteness in that portion of the *mesentery* which connects the spleen, stomach, and small intestine. On examining the spots with the microscope, they proved to be *Cistoid entozoa*, of a species that I have not seen before, nor do I believe they have yet been described. Seen with low power, they appeared to be identical with *Trichina spiralis*, found occasionally (and only found) in human muscle, wanting, however, the remarkable external cyst, supposed to result from the irritation of the cyst containing the entozoon; but, with increased magnifying power, it is altogether a different animal, simply agreeing with the former in the spiral form it assumes in the cyst.

The body is composed of a great number of delicate segments, while its interior displays a well-developed alimentary canal, possessing a distinctly marked pyloric constriction: moreover, the stomach is provided with a mucous membrane, and muscular coat of considerably density.

On continuing my examination, I found one similar cyst in the centre of the urinary bladder, and three at its neck.

These parasites occupied the fat lobules, and 12 of them, all that there were, occurred in a space less than one-eigth of an inch square. They now form permanent preparations for the microscope.

HENRY GOADBY, M.D.

American Association for the Advancement of Science.

The following notices of the proceedings of this scientific body, at their annual meeting held in the city of Providence, Rhode Island, August 15th, 16th, 17th and 18th, are necessarily extremely brief; but of the more important papers read at the several meetings, we shall have an opportunity of giving more complete abstracts in future numbers of the *Journal:*

PHYSICS.

Notice of Earthquake Waves. By Professor A. D. Bache.—On the 23d of December, 1854, at 9 A. M., an earthquake occurred at Simoda, on the Island of Niphon, Japan, that resulted in the wreck of the Russian frigate Diana. The harbor was first emptied of water, then came in an enormous wave which again receded. (It appeared from the Rev. Mr. Jones that the whole character of the harbor of Simoda, previously surveyed by the Powhatan, has been changed by the earthquake.) A report from the Bonin Islands is not sufficiently exact to use for our main purpose, but points to Simoda as the centre of disturbance. (Simoda, according to the Rev. Mr. Jones, is volcanic; Bonin appears not to be.) Now the Coast Survey has three self-acting tide-gauges at Astoria, on Columbia River, San Francisco and San Diego. They record the rise of the tide on a cylinder turned by a clock. The apparatus is protected more or less from the oscillations that wind-waves would cause, which only cause a trembling of the index or stylus. The gauge at Astoria was but slightly affected by the earthquake wave, owing to the bar on the river and the distance it had to ascend. At San Francisco, 4,800 miles from Simoda, the wave arrived 12 hours 16 minutes after the beginning of the earthquake. A series of seven waves, each about half an hour in duration, or 35 minutes, each series successively smaller, and separated by a quiet time of an hour from the preceding, was recorded at San Francisco. At San Diego the wave had traversed 5,200 miles in 12 hours 38 minutes, and produced likewise a series of seven waves, each nearly corresponding to those at San Francisco, but the second series stronger than the first and third. In height they were less, the highest at San Francisco being .7 of a foot, at San Diego .6. The waves at San Diego could not have come from San Francisco, as they would have arrived much later. The velocity with which a wave travels depends on the depth of the ocean. The second and third series were but repetitions of the first wave that had reached the same points, travelling through shallower water. The calculations based on these data give for the Pacific Ocean a depth of from 14,000 to 18,000 fathoms. It is remarkable how the estimates of the ocean's depth have grown less. La Place assumed it at 10 miles, Whewell at 3.5. while this estimate brings it down to about 2 miles.

Frozen Wells.—Two deep wells at Owego, Tioga county, N. Y., seem to freeze in the latter part of winter, and to remain frozen until September. In the Jurassic formation of Europe, Prof. Guyot alluded to the ice caves common in that formation. He instanced one of these caves, 3000 feet above sea level, about 60 feet deep, whose bottom was always covered with ice several feet in thickness, while stalactites of ice depended from the roof. The whole was a small glacier. The stalactites were formed by water percolating through the covering of the cave. It was also stated that there was a cleft in the mountain not far west of Williams College, called the Snowhole, where snow might always be found. Similar occurrences had also been noticed in a range of mountains, composed of a porous sand rock, in Southern Virginia.

It was remarked by Prof. Agassiz, that he had never been able to find any large accumulations of ice with a temperature much below the freezing point. He would ask if there were any such. Prof. Henry said that during the past winter he had been struck with the fact that pieces of ice wrapped in a cloth were frozen to it, although not one out of the several thermometer would go down to 32. It appeared from this, as from the old observation of La Place, who found that the ice surrounding the worm through which they were transmitting gases was soon frozen to the worm, that melting ice produced a certain degree of cold. The temperature of a mixture of ice and alcohol, in the form of wine, brandy, &c., was lower than 32°. Hence ice and alcohol was a freezing mixture.

Professor Agassiz explained the different kinds of ice. First was that produced by the freezing of the surface of the water and successive layers of water beneath it, a laminated schistose mass. Into this bubbles from the bottom of the pond were frequently frozen, and when it was subjected to the action of the sun the bubbles became heated, melted the ice around them, and rendered it of no marketable value. It would therefore be worth while for ice gatherers to cover their ponds with cloths, or something which would prevent these bubbles from rising. Glacier ice was formed like pudding stone; compact masses being cemented together, so that when you exposed a large lump of glacier ice to the heat of the sun it would crumble in pieces. It was like the decomposition of conglomerate; we had ice sand. Icebergs could be determined to be derived from glaciers, and not to be the frozen surface of the ocean, by their conglomerate composition. Pebbles in glaciers becoming heated melted the ice beneath them, and quarried their way down to where the heat of the sun could not reach them. The pot holes formed in this way were soon covered with a thin film of ice, but it was only during the protracted cold of winter that they were frozen through.

ASTRONOMY.

Solution of the Adams Prize Problem for 1857—Part First. By Prof. Benjamin Pierce.—The problem has for its subject the Motion of Saturn's Rings, allowing them to be solid or fluid, concentric or eccentric, He reserved the consideration of solid rings of immoveable parts for a meeting of the Mathematical section, when by use of formulæ he would prove it untenable. Can it be made up of a mass of satellites moveable among themselves? Then they must be in continual motion among themselves; revolving among themselves about their common centres of gravity, perpetual collisions ere this would have reduced them to powder. We assume now that the rings are fluid. Then they may vary in form. It was first shown that they had varied by Otto Struve. The diameter of the outer part of the ring is not known to have changed. The inner edge is contracting as it seems to me. Huygens, in 1657, made it (allowing for the irradiation of his telescope) 6.5″ Huygens and Cassini, in 1695, made it 6″; Bradley, in 1719, 5.4″; Herschell, in 1799, 5″; Struve, senior, in 1826, 4.36″; Encke and Galle, in 1838, 4.04″; and Otto Struve, in 1851, 3.67″ Does it decrease uniformly? I think it is decreasing more rapidly, and the present rate will bring the ring to an end, in certain parts of it, in about 80 years from now. I will show in the meeting in section that the planet does nothing either to maintain or destroy the equilibrium of the ring. The satellites tend to maintain it in place. The ring is not gas; its density is nearly that of water. If the zodiacal light be a gaseous ring of the earth, it would need some solid parts to give body to it. May that gas be the atmosphere around an infinity of small masses revolving about each other and about the earth? May there not be collisions among these revolving masses that throw down parts of them to the earth? Is not that as good a reservoir of meteors as the moon? Their melted state seems to lead us to a lunar volcanic origin; but unless some lunar volcano pointed expressly at the earth were put in furious operation, such a bombardment could not hit the earth with one in ten thousand of its projectiles. Prof. Pierce is inclined to adopt this hypothesis. The action of Saturn would tend to bring a solid inflexible ring against itself.

Dr. Peters would conclude from the data of Prof. Pierce, that the cataclysm of the contact of the ring would occur about 1893 instead of 1935. But Struve has strangely omitted the observation of Bessel made with the heliometer, a more accurate instrument than the filar micrometer used by Struve at Dorpat, and by Encke and Galle at Berlin. By using these data the time would be reduced so that the present generation may hope to see it.

Prof. Pierce thought the data too imperfect to use in a calculation of time. It does not appear certain that it is not a vibration which will go on in due time to recede again from the planet. But of this we can as yet obtain no evidence.

On the Asteroid Planet. By Prof. S. Alexander.—By a most masterly use of circumstantial evidence of a delicate nature, Prof. Alexander has arrived at almost a certainty that in the space between Mars and Jupiter once revolved a planet a little more than 2.8 times as far from the Sun as our earth. The equatorial diameter was about 70,000 miles, but the polar diameter only 8 miles! It was not a globe but a wafer—nay a disc of a thickness of only 1-9,000 of its diameter. Its time of revolution was 3.698 days, say 3 days 15 hours 45 minutes. The inclination of its orbit to the ecliptic was about 4°. It met a fate that might have been anticipated from so thin a body, whirling so furiously, for its motion on its axis was 1-16th of its velocity in its orbit, say, 2,477 miles per hour. It burst as grindstones and fly-wheels sometimes do. We have found 35 fragments of it and call them asteroids. When it burst some parts were moving 2,477 miles per hour faster than the centre did, and some as much slower; that is, some parts moved 4,954 miles per hour faster than the others. These described a much larger orbit than the planet did, and the place where it burst was their perihelion. Others described a smaller orbit, because they left that point with a diminished velocity; it was their aphelion. Some flew above the orbit of the planet and had their ascending node. Others flew below, and it was their descending node. They seemed to go almost in pairs. Two went very far out of the plane of the orbit, so that they pass the limits of the zodiac, and it is found that the ascending node of 18 correspond nearly with the descending node of 17, so nearly even were they distributed. And thin as was the planet, it had not cooled so much at the time of the explosion that none of the fragments could assume a spherical form.

The planet's place was first to be found. Three or four independent processes were used for this, and they agreed surprisingly. He interpolated it as a lost term in a geometric series, from Mars to Saturn, for the first approximation. He compared it with Saturn and Jupiter, and with Mars and Jupiter. He found where a planet would be dropped off in the successive cooling and contracting of the solar system. And he compared its orbit for size and ellipticity with those of the asteroids. Some of them gave solutions very far from the average. Rejecting these, the others coincided with previous deductions and with each other surprisingly. Its day he found by Kirkwood's analogy. Its equatorial diameter was the result of two calculations, one of which would inevitably give a result too large, and the other too small, in all cases when the planet did not explode at its equinox, when it would be exact. These numbers were 78,425 and 68,646 miles. A just comparison gave 70,470. But we can follow these calculations no further.

It is curious to see how the history of this planet verifies the theory of La Place, that a heavenly body must be either nearly a sphere or a disc, and that the latter must be unstable. And this reminded Prof. Alexander again to allude to the earth's ring—the zodiacal light. He had long been convinced that the moon could not be the only satellite thrown off by our planet in taking on its present form, but knew not where to look for the rest. A more careful calculation of the data furnished by the Rev. Mr. Jones, had given him for the diameter of the ring 17,000 miles, and a time of about half a day for rotation. And curiously enough, half a day was the time that had been assigned by a previous calculation for the revolution of an ærolite round the earth.

Solar Red Flames.—Professors Alexander and Henry were observing together upon this phenomenon. It is now settled that this red light comes from the edge of the sun, and can be seen only by the aid of peculiar colored light. But using a large Fresnel lens, and throwing the image two inches in diameter on wood, it took fire, and behold in the smoke I saw the red flames of the sun as seen seventeen years before! And strange to say, they were only visible in the glass which showed the red flame in the sun. When the eye becomes tired by gazing on bright white light, the flame of a candle is invisible through all other screens but that kind; in that it is crimson. It is probably a subjective coloring existing in the eye, and is the result of white light.

GEOLOGY.

Graptolites.—Prof. James Hall gave some notes upon the genus Graptolithus. The genus Graptolithus includes now about ten species of fossil remains, most of which are American, and of some of which Prof. Hall has recently found better specimens than ever before.

They are compound animals of the family Bryozoa, the lowest type of the class Mollusca. They consist of a kind of radiating frame apparently covered in whole or in part with a kind of web, so as to resemble the rays and cloth of a parasol. But they do not radiate from a centre, but from two ends of a line by bifurcation or trichotomy, so as to preserve a bilateral symmetry. The separate rays only have generally been observed, which have been referred to Cephalopoda or Radiata. They appeared to be tubes with one or two rows of serratures on their edges. The Professor now regards these notches as each a part of a simple animal, and that where there is but one row of serratures visible, it is because they are so folded as to hide the other.

Prof. Agassiz thought the case before us a good example of the difficulties with which the fossil zoologist has to contend. Who would ever make out the structure and use of this tool (the parasol) by finding only single sticks of one? The difficulty is greater in a compound animal, for if a man substituted the laws that hold a community together for the physiological laws that prevail in the human system, he would go widely astray. But Prof. Agassiz had met something very like the Graptolithus among the marine animals of Key West, furnished him by the Coast Survey. And here we find a further instance of the fact that ancient races, extinct in the Eastern Hemisphere, are still represented by a few species in the New World.

The Mauvaises Terres.—Professor James Hall gave some account of the Geology of Nebraska and the Mauvaises Terres. The country on the Upper Missouri River—Nebraska—he said, had been known to us for many years. Until within a few years past our knowledge had been derived from Lewis and Clark, Nicolay and some others. All these had brought specimens from Nebraska, from which we had learned that for a great distance along the Missouri river, beginning at the mouth of the Platte, and extending several hundred miles northerly, there was a cretaceous formation, the most prominent fossils of which were Ammonites and Baculites. All had shown that this existed in a largely developed scale, but with the exception of Nicolay, no attempt was made to establish subdivisions. In 1847 we had for the first time a published notice of the existence of an extensive tertiary formation in that region, given by Dr. Prout, of St. Louis. This was, however, to the West of Missouri. Subsequently Mr. Culbertson brought collections, and Dr. Owen directed Mr. Evans to make collections, from which we had a pretty good knowledge of tertiary and its mammalia. Mr. Hall's principal object in making collections was not to make discoveries of new species, but the investigations of Dr. Owen did not tell us whether there were distinct formations or not, and moreover it seemed an important consideration that the flora corresponding to the ancient fauna should be known. That was not accomplished by the expedition, but we had some more details with regard to the tertiary and cretaceous formations. In the neighborhood of the mouth of the Platte the carboniferous formation terminated. Passing up the Missouri we found that the carboniferous passed into cretaceous. At their junction was a sandstone which might perhaps be older than the cretaceous. Upon it lay a buff calcareous rock, which would mark like chalk, containing scales and jaws of fishes. Above this was a great thickness of clays which contained most of the species that had been brought from this part of the country. A thinner bed above the clay was characterized by a large baculites. Those subdivisions extended over the western country, and we had yet to seek their characteristic fossils. The species already described already amounted to between thirty and forty, and he had about an equal number of new species. At a considerable distance west of the Missouri the cretaceous beds began to dip slightly to the west. Above the bed characterized by baculites and 80 miles west of the Missouri commenced the tertiary, at first containing no fossils, but about 80 miles further on there were palæotherium and fossil turtles within twenty feet of the cretaceous, although the tertiary nearer the river was 50 or 60 feet high. They concluded, therefore, that the beds were unconformable, the cretaceous dipping westward and the tertiary being deposited horizontally upon it, so that the eastern tertiary began to be deposited when the western was already 250 feet thick. The mauvaises terres were formed of this tertiary extensively denuded. Two new species of mammals had been discovered, one of them allied to the musk deer and the other a small carniverous animal. He was indebted to Mr. Meek and Mr. Hayden for the specimens which he exhibited. The shortest term to express the character of Nebraska was to say that it was a perfect desert, incapable of supporting men or animals except in a migratory condition. The buffaloes came in the spring with the grass, and went away in midsummer when it was gone, and the Indians followed them. There was almost no wood; some few shrubby willows, and a cotton-wood a foot in diameter was always known as the big cotton-wood, and now that it was gone the place was still called Big Cotton Wood Spring. Pure water was rarely met with. There were occasionally some springs in the baculite formation which commenced 75 miles west of the Missouri. The deep clay beneath it was almost impassable. In the spring it was all mud, and in the summer the clay cracked so as to draw out the roots of vegetation and destroy it. Along the bottoms were occasionally a little good soil, but it was not valuable. This clayey soil was dark, but not with organic matter. He had seen in Mr. Meek's notes that night after night he was compelled to camp with bitter water, and send out the men to gather a few stunted willows or cotton-wood for fire. Most of the water was impregnated with saline materials; and as all the water in the Mauvaise Terres contains sulphate of magnesia, the party was compelled to submit to its medicinal effects. Southward toward the Platte was some better land but little wood. Kansas was much like Nebraska, and the climate was such that in a great part of the territory it would be difficult for New England men to exist. He knew that Nebraska was a desert, and would remain so for all time to come. [This curse of barrenness does not apply to settled portions of Kansas. They are carboniferous.]

On the Polishing of Granite by Driving Sand. By Mr. Wm. Blake —A short paper on the cutting and polishing of granite by driving sand in the Colorado Pass, was read by Mr. Blake, who exhibited specimens of the grooves and channels, as well as of the polished surface of the rock. The whole surface of the granite in the pass, he said, was cut into long and beautiful grooves, which had a fine polish. Even quartz was cut away and polished by the incessant action of the sand. Garnets imbedded in feldspar stood out and protected the feldspar behind them. The little fingers of stone thus produced all pointed to a constant west wind drawing through the pass. This grooving and polishing might be seen in all parts of the desert where there were rocks to be acted upon. The polish was not like that of the lapidary, but looked more as though the rocks had been oiled or varnished. Some of the grooving and polishing which had been ascribed to glaciers, might perhaps be referred to this cause.

Prof. Agassiz said that he was particularly interested in these phenomena, since he had devoted so many years to the study of the glaciers. To know that there was another series of phenomena similar to the glacial was very interesting, and suggested caution in ascribing any apparent phenomenon to either the one or the other cause. He was pleased to see that no objection had been made to the possibility of glaciers having produced similar phenomena, and that their existence was acknowledged by Mr. Blake. It became necessary to distinguish the two sets of phenomena. Sand in order to be moved over such surfaces must be of very nearly uniform size. Now in the glacier we had two different phenomena produced simultaneously, one was the polishing of the surfaces, and the other the grooving and scratching produced by the larger masses of rock in the glacier. These features were certainly sufficient to distinguish between glacial action and the wearing of currents of sand.

Coal Fields of Missouri and Illinois.—Prof. Hall expressed an opinion that about three-fourths of the Missouri and Illinois coal fields marked out by Owen would have to be wiped off the map, and its place supplied by silurian, with its pentamerus, oblongus, and other characteristic fossils. He had seen lower silurian and upper silurian fossils over large areas of Owen's coal fields. He supposed most of that coal to be outlayers resting in basins, and having no connection with each other.

Geology in America.

An Address delivered before the American Association for the Advancement of Science, assembled at Providence, Rhode Island, August 17th, 1855, by Professor James D. Dana.

In selecting a topic for this occasion, I have not been without perplexity. Before an Association for the Advancement of Science—Science in its wide range—a discourse on the progress of science in America for the past year would seem legitimate. Yet it is a fact that original memoirs in most departments, published within that period, would make a very meagre list. Moreover, it is too much to expect of any one to roam over others' territories, lest he ignorantly gather for you noxious weeds. I have, therefore, chosen to confine myself to a single topic—that of Geology, and I propose, instead of simply reviewing recent geological papers, to restrict myself to some of the general conclusions that flow from the researches of American Geologists, and the bearings of the facts or conclusions on geological science.

I shall touch briefly on the several topics, as it is a subject that would more easily be brought into the compass of six hours than one. In drawing conclusions among conflicting opinions, or on points where no opinion has been expressed, I shall endeavour to treat the subject and the views of others in all fairness, and shall be satisfied if those who differ from me shall acknowledge that I have honestly sought the truth.

In the first place, we should have a clear apprehension of the intent or aim of Geological Science. It has been often said that geology is a *history*, the records of which are in the rocks; and such is its highest department. But is this clearly appreciated? If so, why do we find text-books, even the highest in authority in the English language, written back-end foremost—like a history of England commencing with the reign of Victoria? In history, the phases of every age are deeply rooted in the preceding and intimately dependent on the whole past; there is a literal unfolding of events as time moves on, and this is eminently true of geology.

Geology is not simply the science of rocks; for rocks are but incidents in the earth's history, and may or may not have been the same in distant places. It has its more exalted end—even the study of the progress of life from its earliest dawn to the appearance of man; and instead of saying that fossils are of use to determine rocks, we should rather say that rocks are of use for the display of the succession of fossils. Both statements are correct, but the latter is the fundamental truth of the science.

From the progress of life geological time derives its division into Ages, as has been so beautifully exhibited by Agassiz. The successive phases in the progress of life are the great steps in the earth's history. What if in one country the rocks make a consecutive series without any marked interruption between two of these great ages, while there is a break, or convenient starting-point, in another? Does this alter the actuality of the ages? It is only like a book without chapters, in one case, and with arbitrary sections in another? Again, what if the events characteristic of an age, that is, in geology, the races of plants or animals—appear to some extent in the preceding and following ages, so that they thus blend with one another? It is but an illustration of the principle just stated, that *Time is One*—ages have their progressive developement, flowing partly out of earlier time, and casting their lights and shadows into the far future. We thus distinguish the ages by the culmination of their great characteristics, as we would mark a wave by its crest.

Divisions of time *subordinate* to the great ages will necessarily depend on revolutions in the earth's surface, marked by an abrupt transition either in the organic remains of the region, or in the succession of rocks. Such divisions are not universal. Each continent has its own periods and epochs, and the geologists of New York and other States have wisely recognized this fact—disregarding European stages or subdivisions. This is as true a principle for the cretaceous and tertiary, as for the Silurian and Devonian. The usurpation of Cromwell made an epoch in English annals—not in the French or Chinese. We should study carefully the records before admitting that any physical event in America was contemporaneous with one in Europe. The unity in geological history is in the progress of life, and in the great physical causes of change—not in the succession of rocks.

The Geological Ages, as laid down by Agassiz, are the following:—I. The *Age of Fishes*—including the Silurian and Devonian. II. The *Age of Reptiles*—embracing from the Carboniferous through the Cretaceous. III. The *Age of Mammals*, or the Tertiary and Post-Tertiary. IV. The *Age of Man*, or the recent era—*fishes* being regarded as the highest and characteristic race of the first age, *reptiles* of the second, and *mammals* of the third.

More recent researches abroad, and also the investigations of Mr. Hall in this country, have shown that the supposed fish remains of the Silurian are probably fragments of *Crustacea*, if we except those of certain beds near the top of the Silurian; and hence the Age of Fishes properly begins with the Devonian. What, then, is the Silurian? It is pre-eminently the AGE OF MOLLUSCS.

Unlike the other two Invertebrate Sub-kingdoms—the Radiate and Articulate, which also appear in the earliest fossiliferous beds—the Molluscan Sub-kingdom is brought out in all its grander divisions. There is not simply the type, but the type analyzed or unfolded in its several departments from the Brachiopods and Bryozoa up to the highest group of all—the Cephalopods. And among these Cephalopods, although they may have been inferior in grade to some of later periods, there were species of gigantic size—the shell reaching the length of ten or twelve feet. The Silurian is, therefore, most appropriately styled the MOLLUSCAN AGE.

The Palæozoic Tribolites were the lowest among Crustacea, and Crustacea rank low among Articulates; moreover, Crustacea (and the Articulata in general) did not reach their fullest development until the Human Era.

The Radiata were well represented in the Silurian periods, but, while inferior to the Mollusca as a Sub-kingdom, only the Corals and Crinoids —the lower fixed or vegetable species—with rare exceptions, occur in the Silurian or Molluscan Age.

Viewing the history, then, zoologically, the ages are, the Age of Molluscs—of Fishes—of Reptiles—of Mammals—of Man.

We may now change the point of view to the Vegetable Kingdom. The ages thence indicated would be three:—

I. The *Age of Algæ* or Marine Plants—corresponding to the Silurian and Devonian.

II. The *Age of Acrogens*, or Flowerless Trees—that is, the *Lepidodendra, Sigillariæ*, and *Calamites*—corresponding to the Coal Period and the Permian—a name first proposed by Brongniart, and which may still be retained, as it is far from certain that the Sigillariæ and Calamites are most nearly related to the *Coniferæ*.

III. The *Age of Angiosperms*, or our common trees—like the oak, elm, &c.—beginning with the Tertiary.

The interval between the second and third of these ages is occupied mainly by Coniferæ, the pine tribe, and Cycadeæ, the true Gymnosperms, species of which were abundant in the Coal period, and have continued common ever since. The Coniferæ, in the simplicity of their flowers and their naked seeds, are next akin to the Acrogens, or flowerless trees. Although in the main a flowerless vegetation—for the supposed remains of flowers observed abroad have been recently referred to undeveloped leaf buds—it appears from the observations of Dr. Newberry, that there were true flowers over the Ohio prairies, apparently monocotyledinous, and related to the lily tribe. But no palms or monocotyledinous trees have been found here.

Combining the results from the Animal and Vegetable Kingdoms, we should introduce the age of Acrogens, for the Coal period and Permian between the age of Fishes and the age of Reptiles—a space in time zoologically occupied by the overlapping of these two ages.

The order then reads: the age of Molluscs, of Fishes, of Acrogens or Coal Plants, of Reptiles, of Mammals, of Man.

The limits of these ages are as distinct as History admits of; their blendings where they join, and the incipient appearance of a type before the age it afterward characterizes fully opens, are in accordance with principles already explained.

The reality of progress from lower to higher forms is not more strongly marked in these names properly applied than in the rocks. If hereafter mammals, reptiles, or fishes are found a little lower than now known, it will be changing but a sentence in the history, not the grand idea which pervades it.

A theory lately broached by one whose recent death has caused universal grief to science, supposes that the Reptilian was an age of diminished life between the two extremes in time—the Palæozoic and Mammalian ages. But in fact, two grand divisions of animals, the Molluscan and Reptilian, at this time reach their climax and begin their decline, and this is the earliest instance of the highest culmination of a grand zoological type.

Preceding the Silurian of Molluscan Age, there is the Azoic Age, or age without animal life. It was so named by Murchison and De Verneuil, and first recognised in its full importance and formally announced in this country in the Geological Report of Messrs. Foster and Whitney, although previously admitted as a general fact by most geologists.

It embraces all the lowest rocks up to the Silurian, for much of the lowest granite cannot be excluded. The actual absence of animal life in the so-called Azoic Age in this country is rendered highly probable, as Foster and Whitney show, by the fact that many of the rocks are slates and sandstones, like fossiliferous Silurian rocks, and yet have no fossils; and, moreover, the beds on this continent were uplifted and folded, and to a great extent crystallized on a vast scale, before the first Silurian layers were deposited. A grand revolution is here indicated, apparently the closing event of the early physical history of the globe. As plants may live in water too hot or impure for animals, and moreover since all nature exemplifies the principle that the earth's surface was occupied with life as soon as fitted, and with the highes forms the conditions of the time allowed, we may reasonably infer that there may have been in Azoic times marine plants and plant infusoria, forms adapted to aid in the earth's physical history; and this vegetation may have long preceded animal life on the globe.

After these general remarks on the divisions of geological time, I now propose to take up the characteristic features and succession of events in American Geology.

In the outset we are struck with the comparative simplicity of the North American continent, both in form and structure. In outline it is a triangle, the simplest of mathematical figures; in surface it is only a vast plain, lying between two mountain ranges, one on either border; the Appalachian, from Labrador to Alabama on the east, the Rocky Mountains on the west; and on its contour it has water, east, west, north, south.

Observe, too, that its border heights are proportioned to the size of the oceans. A *lofty* chain borders the Pacific, a *low* one the narrow Atlantic; while the small Arctic is faced by no proper mountain range.

This principle, that the highest mountains of the continents face the largest oceans, is of wide application, and unlocks many mysteries in physical geography. South America lies between the same oceans as North America; it has its eastern low range, its western Andes; and as the oceans widen southward, the continent is there pinched up to almost a narrow mountain ridge; it differs from North America in having a large expanse of ocean, the Atlantic, on the north, and correspondingly it has its northern mountain ridge. The world is full of such illustrations, but I pass them by.

This simplicity of ocean boundary, of surface features and of outline, accounts for the simplicity of geological structure in North America; or we may make the wider statement, that all these qualities are some way connected with the position and extent of the ocean, they seeming to point to the principle that the subsidence of the oceanic basins has determined the continental features. America has thus the simplicity of a single evolved result. Europe, on the contrary, is a world of complexities. It is but one corner of the oriental continent, which includes Europe, Asia, and Africa, and while the ocean bounds it on the north and west, continental lands enclose it on the south and east. It has ever been full of cross purposes. American strata often stretch from the Atlantic west beyond the Mississippi; and east of the Rocky Mountains, it has but one proper mountain range of later date than the Silurian. Europe is much broken up into basins, and has mountains of all ages; even the Alps and Pyrenees are as recent as the tertiary. This wide contrast accounts for the greater completeness or generality of American revolutions, and the more abrupt limits of periods and clearer exhibition of many geological principles.

The geological structure of this country has been made known through the combined researches of a large number of investigators. The names of Maclure, Silliman, Eaton, lead off the roll. Hitchcock, the Professors Rogers, the well-known Geologists of the New York Survey, Owen, Percival, Morton, Conrad, Tuomey, and many others, have contributed to the collected results. Yet the system may be said to have been mainly laid open by three sets of observers—Morton and Conrad for the Cretaceous and Tertiary, the New York Geologists for the Palæozoic strata; and the Professors Rogers for the Carboniferous beds and the Appalachians.

The succession of Silurian and Devonian rocks in the State of New York is the most complete in the country, and it was well for the science that its rocks were so early studied, and with such exactness of detail. The final display of the Palæontology by Mr. Hall has given great precision to the facts, and the system has thereby become a standard of comparison for the whole country, and even for the world. This accomplished, the carboniferous rocks were still to be registered, and the grand problem of New England Geology solved. The Professors Rogers, in the survey of Pennsylvania and Virginia, followed out the succession of strata from the Devonian through the Coal period, and thus in a general way completed the series. And more than this, they unravelled with consummate skill the contortions among the Appalachians, bringing order out of confusion, and elucidating a principle of mountain-making which is almost universal in its application. They showed that the Silurian, Devonian, and Carboniferous strata, which were originally laid out in horizontal layers, were afterward pressed on to the north-westward, and folded up, till the folds were of mountain height, and thus the Appalachians had their origin; and also, that by the escaping heat of those times of revolution extensive strata were altered or even crystallized.

This key soon opened to us a knowledge of New England Geology, mainly through the labours of Mr. Hall, and also Professor H. D. Rogers, following up the survey of Pres. Hitchcock; and now these so-called primary rocks, granite, gneiss, mica-schist, and crystalline limestones, once regarded as the oldest crystallizations of a cooling globe, are confidently set down as for the most part no older than the Silurian, Devonian, and Carboniferous beds of New York and Pennsylvania.

Let us now briefly review the succession of epochs in American Geological history.

The Azoic age tended, as was observed, in a period of extensive metamorphic action and disturbance; in other words, in a great revolution. At its close, some parts of the continent were left as dry land, which appear to have remained so as a general thing in after times; for no subsequent strata cover them. Such are a region in Northern New York, others about and beyond Lake Superior, and a large territory across the continent from Labrador westward, as recognized by Messrs. Whitney and Foster, and the geologists of Canada.

The Silurian or Molluscan Age next opens. The lowest rock is a sandstone, one of the most widely spread rocks of the continent, stretching from New England and Canada south and west, and reaching beyond the Mississippi—how far is not known. And this first leaf in the record of life is like a title-page to the whole volume, long afterward completed; for the nature of the history is here declared in a few comprehensive enunciations.

1. The rock from its thin, even layers and very great extent shows the wide action of the ocean in distributing and working over the sands of which it was made; and the ocean ever afterward was the most active agency in rock-making.

2. Moreover, ripple-marks such as are made on our present sea-shores or in shallow waters, abound in the rock both through the east and west, and there are other evidences also of moderate depth and of emerged land. They all announce the wonderful fact that even then, in that early day, when life first began to light up the globe, the continent had its existence—not in embryo, but even of full-grown extent, and the whole future record is but a working upon the same basis and essentially within the same limits. It is true that but little of it was above the sea, but equally true that little of it was at great depths in the ocean.

3. Again, in the remains of life which appear in the earliest layers of this primal rock, three of the four great branches of the animal kingdom are represented: Molluscs, Trilobites among Articulates, Corals and Crinoids among Radiates—a sufficient representation of life for a title-page. The New York beds of this rock had afforded only a few Molluscs, but the investigations of Owen in Wisconsin have added the other tribes; and this diversity of forms is confirmed by Barrande in his Bohemian researches. Among the genera, while the most of them were ancient forms that afterwards became extinct—and through succeeding ages thousands of other genera appeared and disappeared—the very earliest and most universal was one that now exists—the genus *Lingula*—thus connecting the extremes of time, and declaring most impressively the unity of creation. Mr. Hunt, of the Canada Geological Survey, recently discovered that the ancient shell had the anomalous chemical constitution of bones, being mainly phosphate of lime, and afterward he found in a modern Lingula the very same composition—a further announcement of the harmony between the earliest and latest events in geological history.

The earliest sandstone, called in New York the Potsdam sandstone, and the associate calciferous sand-rock, mark off the *First Period* of the Molluscan Age, the *Potsdam Period*, as it may be called.

Next followed the *Trenton Period*—a period of limestones (the Trenton limestone among them) equal to the earlier beds in geographical limits, and far more abundant in life, for some of the beds are literally shells and corals packed up in bulk; yet the species were new to the period, the former life having passed away; and even before the Trenton period closes, there were one or two epochs of destruction of life, followed by new creations. The formation of these limestone beds indicated an increase in the depth of the continental seas—an instance of the oscillation of level to which the earth's crust was almost unceasingly subject through all geological ages until the present.

After the Trenton period, another change came over the continent, and clayey rocks or shales were formed in thick deposits in New York and to the south—the Utica Slate and Hudson River Shales—while limestones were continued in the west. This is the *Hudson Period*, and with it the *Lower Silurian* closed.

The seas were then swept of their life again, and an abrupt transition took place both in species and rocks. A conglomerate covered a large part of New York and the States south, its coarse material evidence of an epoch of violence and catastrophe; and with this deposit the *Upper Silurian* begins.

The Upper Silurian has also its three great periods—the *Niagara*.

the *Onondaga*, the *Lower Helderberg*, and many subordinate epochs—each one characterized by its peculiar organic remains; each evidence of the nearly or quite universal devastation that preceded it, and of the act of omnipotence that re-instated life on the globe, each, too, bearing evidence of shallow or only moderately deep waters when they were formed; and the Onondaga period—the period of the New York salt rocks—telling of a half emerged continent of considerable extent.

Another devastation took place, and then opened, as De Verneuil has shown, the Devonian Age, or Age of Fishes. It commenced, like the Upper Silurian, with coarse sandstones, evidence of a time of violence; these were followed by another grit-rock, whose few organic remains show that life had already re-appeared. Then another change—a change evidently in depth of water—and limestones were forming over the continent, from the Hudson far westward; the whole surface became an exuberant coral-reef, far exceeding in extent, if not in brilliancy, any modern coral sea; for such was a portion, at least, of the *Upper Helderberg* period.

Again, there was a general devastation, leaving not a trace of the former life in the wide seas; and where were coral reefs, especially in the more eastern portion of the continental seas, sandstones, and shales accumulated for thousands of feet in thickness, with rarely a thin layer of limestone. Thus passed the *Hamilton*, *Chemung*, and *Cattskill Periods* of the Devonian Age. The life of these regions, which in some epochs was exceedingly profuse, was three or four times destroyed and renewed, not renewed by a re-creation of the same species, but of others; and although mostly like the earlier in genera, yet each having characteristic marks of the period to which it belonged. And while these Devonian periods were passing, the first land plants appeared, foretellers of the age of verdure next to follow.

Then come vast beds of conglomerate, a natural opening of a new chapter in the record; and here it is convenient to place the beginning of the Carboniferous, or the Age of *Acrogens*. Sandstone and shales succeeded reaching a thickness in New Jersey and Pennsylvania, according to Professor Rogers, of thousands of feet; while in the basin of the Ohio and Mississippi, in the course of this era, the carboniferous limestone was forming immense Crinoidal plantations in the seas.

Another extermination took place of all the beautiful life of the waters, and a conglomerate or sandstone was spread over the encrinital bed; and this introduced the true Coal period of the Carboniferous Age; for it ended in leaving the continent, which had been in long continued oscillations, quite emerged. Over the regions where encrinites were blooming, stretch our vast prairies or wet meadows of the luxuriant coal vegetation. The old system of oscillation of the surface still continues, and many times the continent sinks to rise again—in the sinking extinguishing all continental life, and exposing the surface to new depositions of sandstone, clays, or limestone, over the accumulated vegetable remains; in the rise depopulating the seas by drying them up, and preparing the soil for verdure again; or at times convulsive movements of the crust carry the seas over the land, leaving destruction behind. Thus by repeated alternations the coal period passes—some 6000 feet of rock and coal beds being formed in Pennsylvania, and 14,000 feet in Nova Scotia.

I have passed on in rapid review, in order to draw attention to the series or succession of changes, instead of details. So brief an outline may lead a mind not familiar with the subject to regard the elapsed time as short, whereas, to one who follows the various alternations and the whole order of events, the idea of *time immeasurable* becomes almost oppressive.

Before continuing the review I will mention some conclusions which are here suggested:

1. In the first place, through the periods of the Silurian and Devonian, at twelve distinct epochs at least, the seas on this American Continent were swept of nearly all existing life, and as many times it was repeopled, and this is independent of many partial exterminations and renewals of life that at other times occurred.

If omnipotent power had been limited to making monads for after development into higher forms, many a time would the whole process have been utterly frustrated by hot water, or by mere changes of level in the earth's crust, and creation would have been at the mercy of dead forces. The surface would have required again and again the sowing of monads, and there would have been a total failure of crops after all; for these exterminations continue to occur through all geological time into the Mammalian Age.

2. Again, I have observed that the Continent of North America has never been the deep ocean's bed, but a region of comparatively shallow seas, and at times emerging land, and was marked out in its great outlines even in the earliest Silurian. The same view is urged by De Verneuil, and appears now to be the prevailing opinion among American geologists. The depth at times may have been measured by the thousand feet, but not by miles.

3. During the first half of the Lower Silurian Era, the whole East and West were alike in being covered by the sea. In the first or Potsdam period, the Continent was just beneath its surface. In the next, or Trenton period, the depth was greater, giving purer waters for abundant marine life. Afterwards the east and west were in general widely diverse in their formations; limestones, as Mr. Hall and the Profs. Rogers have remarked, were in progress over the west; that is, the region now the great Mississippi Valley, beyond the Appalachians; while sandstones and shales were forming through north-eastern New York, south and south-west through Virginia. The former, therefore, has been regarded as an area of deeper water; the latter as in general shallow, when not actually emerged. In fact, the region toward the Atlantic border, afterward raised into the Appalachians, was already, even before the Lower Silurian Era closed, the higher part of the land; it lay as a great reef, or sand bank, partly hemming in a vast continental lagoon, where corals, encrinites and molluscs grew in profusion; thus partly separating the already existing Atlantic from the interior waters.

The oscillations or changes of level over the continent through the Upper Silurian and Devonian had some reference to this border region of the continent; the formations approach or recede from it, and sometimes pass it, according to the limits of the oscillations eastward or westward. Along the course of the border itself, there were deep subsidences in slow progress, as is shown by the thickness of the beds. It would require much detail to illustrate these points, and I leave them with this bare mention.

The Hudson River and Champlain valleys appear to have had their incipient origin at the epoch that closes the Lower Silurian; for while the preceding formations cross this region, and continue over New England, the rocks of the Niagara and Onondaga periods (the first two of the Upper Silurian) thin out in New York before reaching the Hudson River. Mr. Logan has recognized the division of America to the north-east into two basins, by an anticlinal axis along Lake Champlain, and observes also that the disturbances began as early at least as the close of the Lower Silurian, mentioning, too, that there is actually a want of conformity in Gaspè between the beds of the Upper and Lower Silurian—another proof of the violence that closed the Lower Silurian era.

But let us pass onward in our geological review. All the various oscillations that were in slow movement through the Silurian, Devonian and Carboniferous ages, and which were increasing their frequency throughout the last, raising and dipping the layers in many alternations, were premonitions of the great period of revolution, so well elucidated, as already observed, by the Professors Rogers, when the Atlantic border, from Labrador to Alabama, long in preparation, was at last folded up into mountains, and the Silurian, Devonian and Carboniferous rocks were baked and crystallized. No such event had happened since the revolution closing the Azoic period. From that time on, all the various beds of succeeding ages, up to the top of the Carboniferous, had been laid down in horizontal or nearly horizontal layers—over New England as well as in the West; for the continent from New England westward, we have reason to believe, was then nearly a plain either above or below the water; there had been no disturbances except minor uplifts; the deposits with small exceptions were a single unbroken record, until this Appalachian revolution.

This epoch, although a time of vast disturbances, is more correctly contemplated as an epoch of the slow-measured movement of an agency of inconceivable power, pressing forward from the ocean toward the north-west; for the rocks were folded up without the chaotic destruction that sudden violence would have been likely to produce. Its greatest force and its earliest beginning was to the north-north-east. I have alluded to the disturbances between the Upper and Lower Silurian beds of Gaspè to the North. Another epoch of disturbance, still more marked, preceded (according to Mr. Logan) the carboniferous beds in those north-eastern regions; and New England, while a witness to the profound character and thoroughness of the Appalachian revolution, attests also to the greater disturbance toward its north-eastern limits. Some of the carboniferous strata were laid down here in Rhode Island, as clay and sand, and layers of vegetable debris; they came forth from the Appalachian fires as you have them, the beds contorted, the coal layers a hard silicious anthracite or even graphite in places, the argillaceous sands and clays, crystallized into talcose, or even gneiss and syenite.

These very coal beds, so involved in the crystalline rocks, are part of the proof that the crystalization of New England took place after the coal age. Fossils in Maine and Vermont add to the evidence. The quiet required over the continent, for the regular succession and undisturbed condition of the rocks of the Silurian, Devonian and Carboniferous formations, shows that in neither of those ages could such vast results of metamorphic action and upheaval have taken place.

The length of time occupied by this revolution is beyond all estimate. Every vestige of the ancient Carboniferous life of the continent disappeared before it. In Europe a Permian period passed with its varied life; yet America, if we may trust negative evidence, still remained desolate. The Triassic period next had its profusion of living beings in Europe, and over 2,000 feet of rocks. America, through all, or till its later portions, was still a blank, nor till near the beginning of the Jurassic period do we find any traces of new life, or even of another rock above the Carboniferous.

What better evidence could we have than the history of the oscillations of the surface, from the earliest Silurian to the close of the Carboniferous age, and the final cresting of the series in this Appalachian revolution, that the great features of the continent had been marked out from the earliest time? Even in the Azoic, the same north-east and south-west trend may be observed in Northern New York and beyond Lake Superior, showing that although the course of the great Azoic lands was partly east and west, the same system of dynamics was then to some extent apparent, or at least in development.

The first event in the records after the Appalachian revolution is the gathering up of the sands and fragments of the crystalized rocks and schists along the Atlantic border into beds—not over the whole surface, but in certain valleys which lie parallel with the Appalachian chain, and which are evidently a result of the foldings of that revolution. The beds are the red sandstone and shales which stretch on for 120 miles in the Connecticut Valley; and similar strata occur in South-eastern New York, in New Jersey, Virginia and North Carolina. These long valleys are believed to have been estuaries or river courses. The period of these deposits is regarded as the earlier Jurassic by Prof. Wm. H. Rogers. Dr. Hitchcock supposes that a portion of the preceding or Triassic period may be represented. Many of the layers show by their shrink-cracks, ripple marks and foot prints, as others have observed, that they were formed in shallow waters, or existed as an exposed mud flat. But they accumulated till they were over a thousand feet thick in Virginia, and in New England two or three thousand, according to the lowest estimate. Hence the land must have been sinking to a depth equal to this thickness, as the accumulations went on, since the layers were formed successively at or near the surface.

Is it not plain, then, that the oscillations, so active in the Appalachian revolution, and actually constituting it, had not altogether ceased their movements, although the times were so quiet that numerous birds and reptiles were tenants of the Connecticut region? Is it not clear that these old valleys, occurring at intervals from Nova Scotia to South Carolina, originally made by foldings of the earth's crust, were still sinking?

And did not the tension below of the bending rocks finally cause ruptures? Even so. And the molten rock of the earth's interior which then escaped through the crystaline rocks beneath and the overlying sandstone, constitutes the trap mountains, ridges and dykes, thickly studding the Connecticut Valley, standing in palisades along the Hudson, and diversifying the features of New Jersey and parts of Virginia and North Carolina. The trap is a singularly constant attendant on the sandstone, and everywhere bears evidence of having been thrown out soon after the deposition of the sandstone, or in connection with the formation of its later beds. Even the small sandstone region at Southbury, Ct., has its trap. Like the Appalachian revolution this epoch had its greatest disturbances at the North.

Thus ended in fire and violence, and probably in submergence beneath the sea, the quiet of the Connecticut Valley, where lived, as we now believe, the first birds of creation—kinds that were nameless until some countless ages afterward. Prof. Hitchcock tracked them out, found evidence that they were no unworthy representatives of the feathered tribe, and gave them and their reptile associates befitting appellations.

Such vast regions of eruptions could not have been without effusions of hot water and steam and copious hot springs. And may not these heated waters and vapors, rising up through the crystaline rocks below, have brought up the copper ores that are now distributed in some places through the sandstone? The same cause, too, may have given the prevalent red color to the rock, and produced changes in the adjoining granite.

After the era of these rocks, there is no other American record during the European Jurassic period.

In the next, or Cretaceous period, the seas once more abound in Animal life. The position of the Cretaceous beds around the Atlantic border show that the continent then stood above the sea very much as now, except at a lower level. The Mississippi Valley, which from the Silurian had generally been the region of deeper waters, was even in Cretaceous times occupied to a considerable extent by the sea—the Mexican Gulf then reaching far north, even far up the Missouri, and covering also a considerable part of Texas.

An age later, the Cretaceous species had disappeared, and the Mammalian Age (or the Tertiary, its first period,) begins, with a wholly new Fauna, excepting, according to Prof. Tuomey, some half a dozen species, about which, however, there is much doubt. The *continent was now more elevated than in the preceding age, and the* salt waters of the Mexican Gulf were consequently withdrawn from the region of Iowa and Wisconsin, so as not to reach beyond the limits of Tennessee.

Two or three times in the course of the Tertiary period, the life of the seas was exterminated, so that the fossils of the later Tertiary are not identical with any in the earliest beds, excluding some fish remains—species not confined to the coast waters. The crust of the earth was still oscillating; for the close of the first Tertiary epoch was a time of subsidence; but the oscillation or change of level was slight, and by the end of the Tertiary, the Continent on the east stood within a few feet of its present elevation, while the Gulf of Mexico was reduced nearly to its present limits.

[*To be continued.*]

Preparation of Aluminium.

The following are two methods given by M. St. Claire Deville, for obtaining Aluminium:—

1. SODIUM PROCESS.—Introduce into a glass tube of about an inch in diameter from 200 to 300 grammes of chloride of aluminium, closing the ends with a plug of asbestos; then conduct hydrogen gas, dry, and perfectly free from atmospheric air, into the tube, and heat the chloride of aluminium in this current of gas by means of charcoal. This will have the effect of driving off the hydrochloric acid, chloride of silicium, and chloride of sulphur, with which it is always impregnated. Capsules of as large size as possible, containing each some grammes of sodium, previously crushed between two sheets of dry filter paper, are then introduced into the glass tube. The tube being full of hydrogen, the sodium is melted; and the chloride of aluminium on being heated, will be distilled and decomposed with incandescence, which may be easily moderated. The operation will be complete when all the sodium has disappeared, and the chloride of sodium formed, has absorbed a sufficient quantity of chloride of aluminium to saturate it. The aluminium will now exist in the state of a double chloride of aluminium and sodium, which is a very fusible and volatile compound. the capsules are next to be removed from the glass tube, and placed in a large porcelain tube, furnished with a pipe leading to a receiver. Through this porcelain tube, while heated to a lively red heat, a current of hydrogen, dry and free from air, is caused to pass; and the chloride of aluminium and sodium will be thereby distilled without decomposition, and collect in the receiver. After the operation, all the aluminium will be found collected in the capsules in the form of large globules; these are washed in water, which will carry off a little of the salt produced by re-action, and also some brown silicium. In order to form a single mass of all these globules, after being cleansed and dried, they are introduced into a capsule of porcelain, into which is put, as a flux, a small quantity of the product of the preceding operation—*i. e.*, of the double chloride of aluminium and sodium. On heating the capsule in a muffle to the temperature of about the melting point of silver, all the globules will be seen to unite in a brilliant mass, which is allowed to cool, and then washed. The melted metal must be kept in a closed porcelain crucible until the vapours of the chloride of aluminium and sodium with which the metal is impregnated have entirely disappeared. The metallic mass will then be found surrounded by a light pellicle of alumina arising from the partial decomposition of the flux.

2. PROCESS BY MEANS OF GALVANISM.—This process is carried on by means of the double chloride of aluminium and sodium. For this purpose the aluminium bath is prepared by taking two parts by weight of chloride of aluminium, and adding thereto one part of dry

pulverised marine salt. The whole is mixed in a porcelain capsule, heated to about 200°. The combination will soon take place, with disengagement of heat. The liquid thus obtained is to be introduced into a capsule of glazed porcelain, which is maintained at a temperature of about 200°. The negative electrode is a plate of platinum, upon which the aluminium will be deposited, mixed with marine salt, in the form of a greyish layer. The positive electrode consists of porous vessels, perfectly dry, and containing melted chloride of aluminium and sodium, in which is immersed a cylinder of charcoal, which generates the electricity, and to which pass the chlorine, and a small quantity of chloride of aluminium, arising from the decomposition of the double salt. The double fixed chloride is re-constituted, and the vapours cease. A small number of elements are necessary for decomposing the double chloride, which presents but slight resistance to the action of electricity.

When the platinum plate is sufficiently charged with metalliferous deposit, it is removed, and allowed to cool; the saline mass is then cleaned off, and the plate again introduced into the current. The matter thus detached from the electrode is melted in a porcelain crucible, which is enclosed in an earthenware one; and after cooling, it is treated with water, which dissolves a large quantity of marine salt; and a grey metallic powder is obtained, which is, by several successive meltings, formed into a single mass; the double chloride of aluminium and sodium being employed as a flux for that purpose.

The first portions of metal obtained by this process are nearly always brittle; as fine a product may, however, be obtained by it as by the sodium process; but the chloride of aluminium employed for that purpose must be purer. In fact, by the sodium process, the silicium, sulphur, and iron are carried off by means of hydrogen,—the iron passing off in the state of protochloride; whilst all these impurities remain in the liquid which is decomposed by the battery, and are carried off along with the first portions of metal reduced.

In addition to these processes of M. Deville, we have

M. Bunsen's Method of Preparation.—Take oxide of aluminium obtained either by the calcination of ammoniacal alum, or from sulphate of alumina, or by the decomposition of alum by chloride of barium; and having mixed it with charcoal, introduce the mixture into a stone retort capable of containing about two quarts, and cover it with a thick layer of cement composed of argil and iron scales. Place the retort in a reverberatory furnace, with its neck projecting horizontally therefrom, from 3 to 5 inches, and connect this neck with a glass receiver, for the reception of the chloride of aluminium, which is sublimed on the introduction of chlorine. This gas is introduced into the glass receiver by a tube of large diameter, made of glass not easily fusible. The stone retort is heated to a dull red heat, and a current of chlorine (well washed and dried) is caused to pass therein. Chloride of aluminium is then freely formed; and at the expiration of some hours the receiver will at least contain half a pound of product. When this chloride is well cooled, it is mixed with its equivalent of melted and pulverised chloride of sodium, and heat is applied thereto. The mixture will melt at a temperature below 200° centigrade. It is introduced into a closed porcelain crucible, divided into two compartments by a porcelain partition which does not quite reach to the bottom, and closed by means of a porcelain cover, having two holes for the reception of the conductors of the battery. Six or eight pairs of Bunsen's plates will suffice to separate the aluminium. If the temperature remains at 200° centigrade, the metal will be deposited in the state of powder; and, for the purpose of converting this into a compact mass, pulverised chloride of sodium is gradually introduced into the mixture, until the liquid has reached the temperature of the melting point of silver. After cooling, large balls of aluminium will be found in the mass, which are caused to unite by throwing them into melted sea salt. The ingots thus obtained possess all the characteristics of M. Deville's aluminium.

Modes of testing Building Materials.

At the last meeting of the American Association for the advancement of science Prof. Henry read a paper on the modes of testing building materials and an account of the marbles used at Washington. He had been appointed on a committee to test the material offered for the extension of the Capitol at Washington. The committee had to take into consideration many minute sources of disintegration, such as that every flash of lightning produced an appreciable amount of nitric acid, which diffused in rain water acted on the carbonate of lime, and the action of dust carried by the wind against the building. The committee subjected specimens to actual freezing and after several experiments a good method was obtained. It was found that in ten thousand years one inch would be worn from the blocks by the action of frost. Blocks of 1½ inch cube were subjected to pressure, and thin plates of lead, as had been the case in former experiments, being introduced to equalize any equalities which might occur in the surface. But upon experiment it was found that while one of these cubes would sustain 60,000 pounds without the lead plates, it would sustain only 30,000 with them. They had therefore to invent a machine to cut the sides of the block perfectly parallel, when it was found that the marble which was chosen for the Capitol, from a quarry in Lee, Massachusetts, would sustain about 25,000 pounds to the square inch. The manner of its breaking was peculiar. With the lead plate interposed, the sides which were free first gave way, leaving the pressure on two cones whose bases joined the plates, and whose apexes met each other, and that they then yielded with comparative ease. This marble absorbed water by capillary attraction, and in common with other marbles was permeable to gases. Soon after the workmen commenced placing it in the walls it exhibited a brownish discoloration although no trace of it appeared while the blocks remained in the stonecutter's yard. A variety of experiments were made with a view to ascertain the cause of this phenomenon, and it was finally concluded to be due to the previous absorption by the marble of water holding in solution organic matter, together with the absorption of another portion of water from the mortar. To illustrate the process, he supposed a fine capillary tube with its lower end immersed in water, whose internal diameter was sufficiently small to allow the liquid to rise to the top to be exposed to the atmosphere. Evaporation would take place at the upper surface of the column, and new portions of water would be drawn up to supply the loss, and if this process were continued any material which might be contained in the water would be found deposited at the top of the tube, the point of evaporation. If, however, the lower portion of the tube were not furnished with a supply of water, the evaporation at the top would not take place, and the deposition of foreign matter would not be exhibited, even though the tube itself were filled with water impregnated with impurities. The pores of the marble, so long as the blocks remained in the yard, were in this last condition, but when the same blocks were placed in the wall of the building the water absorbed from the mortar at the interior surface gives the supply of liquid necessary to carry the coloring materials to the exterior surface and deposit it there at the mouths of the pores. The cause of the phenomenon being known, a remedy was readily suggested; the interior surface of the stone was coated with asphaltum, rendering it impervious to the moisture of the mortar, and the discoloration was gradually disappearing. In a series of experiments made some ten years ago he had shown that the attraction of the particles for each other of a substance in a liquid form was as great as that of the same substance in a solid form. Consequently, the distinction between liquidity and solidity did not consist in a difference in the attractive power occasioned directly by the repulsion of heat; but it depended upon the perfect mobility of the atoms, or a lateral cohesion. He might explain this by assuming an incipient crystallization of atoms into molecules, and consider the first effect of heat as that of breaking down these crystals and permitting each atom to move freely around every other. When this crystalline arrangement was perfect, and no lateral motion allowed in the atoms, the body might be denominated perfectly rigid. We had approximately an example of this in cast steel, in which no slipping took place of the parts on each other, or no material elongation of the mass; and when a rupture was produced by a tensile force, a rod of this material was broken with a tranverse fracture of the same size as that of the original section of the bar. In this case every atom was separated at once from the other, and the breaking weight might be considered as a measure of the attraction of cohesion of the atoms of the metal. The effect, however, was quite different when we attempted to pull apart a rod of lead. The atoms or molecules slipped upon each other. The rod was increased in length and diminished in thickness until a separation was produced. Instead of lead we might use still softer materials, such as wax and putty, until we arrived at a substance in a liquid form. This would stand at the extremity of the scale, and between extreme rigidity on the one hand and extreme liquidity on the other, we might find a series of substances gradually shading from one extremity to another. According to the views he had presented, the difference in tenacity of steel and lead did not consist in the attractive cohesion of the atoms, but in their capability of slipping upon each other. From this view it followed that the form of the material ought to have some effect upon its tenacity, and also that the strength of the article depended in some degree upon the process to which it had been subjected. He had for instance found that softer substances in which the outer atoms had freedom of motion, while the inner ones by the pressure of those exterior were more confined, broke unequally, the inner fibres, if he might so call the rows of atoms gave way first and entirely separated, while the exterior fibres showed but little indications of a change of that kind. If a cylindrical rod of lead, three-fourths of a inch in diameter were turned down on a lathe in one part to about half an inch, and then gradually broken by a force exerted in the direction of its length, it would exhibit a cylindrical hollow along its axis of half an inch in length, and at least a tenth of an inch in diameter. With substances of a greater rigidity this effect was less apparent. It existed, however, even in iron, and the interior fibres of a rod of this metal might be entirely separated, while the outer surface presented no appearance of change. From this it would appear that metals should never be elongated by mere stretching, but in all cases by the process of wire drawing or rolling. A wire or bar must always be weakened by a force which permanently increases its length without at the same time compressing it. Another effect of the lateral motion of the atoms of a soft heavy body when acted upon by a percussive force with a hammer of small dimensions in comparison with the mass of metal was that the interior portion of the mass acted as an anvil upon which the exterior portion was expanded so as to make it separate from the middle portions. Prof. Henry exhibited a portion of bar originally four feet long, which had been hammered in that way so as to produce a perforation through the whole length of its axis rendering it a tube. This fact appeared to him to be of great importance in a practical point of view, as it might be connected with many of the lamentable accidents which had occurred in the breaking of the axles of locomotive engines. These ought in all cases to be formed by rolling and not with the hammer.

CANADIAN INSTITUTE.

Council Meeting—September 8th, 1855.

The following gentlemen were provisionally* elected members of the Institute:—

John Wilson, M.P.P.	London.
S. V. Wolcomb	*Hamilton.*
Romeo H. Stephens	Montreal.
Dr. Thomas Cawdry	Cobourg.
Rev. Mr. Geikie	Toronto.
William Hind	"
Geoffrey B. Hall	Nanticoke.
William Mercer	Simcoe.

* During the interval between the Sessions of the Institute, gentlemen desirous of becoming members may be provisionally elected by the Council, when duly proposed, and their election confirmed at the first ordinary meeting of the Institute in the ensuing Session. The formal election of members can only take place at an ordinary or general meeting of the Institute.

The following draft of a Circular from the Council addressed to the members, on the subject of a Building, was submitted, approved of, and copies ordered to be distributed:—

CIRCULAR FROM THE COUNCIL OF THE CANADIAN INSTITUTE.

The anticipated removal of the seat of Government to Toronto, and the consequent ejectment of the Canadian Institute from the rooms allotted to them in the old Government House, has forced on the attention of the Council the necessity of providing accommodation for the Institute in a building suited to the purposes for which it is established, and to the position which it has already achieved as a Provincial Scientific Institution.

In taking the requisite steps for this purpose, one great difficulty has been removed—*by the gift of G. W. Allan, Esq., of* a valuable site in Pembroke Street, on the Moss Park Estate; and, on application being made to the Government, two successive grants of £500 each have since been made in aid of the Building Fund.

Under these very favourable circumstances, the Council have determined upon appealing to the Members of the Institute, as well as to all persons likely to feel an interest in the success of the first purely scientific Institution founded in Upper Canada. The Council anticipate that at least £500 may be thus readily obtained, thereby increasing the Building Fund to £1500, and providing a sum which will justify them in commencing immediate operations.

The building which the Council propose to erect, is designed with a view to additions hereafter, so as ultimately to provide accommodation for the Museum, Library of Reference, Reading Room, and apartments for transacting the ordinary business of the Society; the present cost not to exceed £2,500.

It is proposed that the subscriptions be paid either at once or in the following manner—one-fourth immediately, and the remainder at six, twelve, and eighteen months thereafter; the mode of payment being at the option of the donor.

Gentlemen proposing to subscribe are requested to transmit their names, with their remittances, or a statement of the amounts they intend to subscribe, to the Treasurer, JAMES STEVENSON, Esq., Bank of Montreal, Toronto, as speedily as possible, in order to enable the Council to commence the building without delay.

Building Committee.—G. W. Allan, Esq.; D. Wilson, L.L.D.; H. Croft, D.C.L.; and F. W. Cumberland, Esq.

Toronto, September 4th, 1855.

The Secretary submitted a letter, dated 6th September, 1855, from E. Chads Hancock, Secretary of the Toronto Athenæum, enclosing certified copies of two resolutions of that body, authorizing its immediate amalgamation with the Canadian Institute, and the transfer to the latter of certain portions of its Library and Museum.

Donations since August 1st, 1855.

From the UNITED STATES PATENT OFFICE, *Washington.*

Report of the Commissioners of Patents, year 1854. Arts and Manufactures. Vol. II., Illustrations.

From the SOCIETIES, *through* Mr. ROWSELL.

The Quarterly Journal of the Geological Society, Vol. XI., Part 2, No. 42, May, 1855.

The Journal of the Royal Geographical Society, with Maps and Illustrations. Vol. 24, 1854.

From Dr. JOSEPH WORKMAN.

Insanity of King George III.; Dr. Ray.

From the AUTHOR, *through* Dr. CHEWETT.

Map of the Province of Canada, and the Lower Colonies, showing the connection by steam navigation with the United States and with Europe, by the route of the great Lakes, and showing also the connection by Railroads and Canals with the New England and the North-western States of the Union, prepared for the Canadian Commissioners of the Paris Exhibition, by Thomas C. Keefer, C.E.

Mercator's Projection, with the Great Circle [shortest sailing] or air lines, illustrating the directions and capacities of the River St. Lawrence, from Lake Erie to the Atlantic, as a means of communication between Europe and the commercial centre of the Great West; showing also, the extension of the Northern Pacific railway route through Canada to the nearest Atlantic sea-port at Montreal. Prepared for the Canadian Commissioners of the Paris Exhibition, by Thomas C. Keefer, C.E.

From J. M. Street, Esq.

Report on the Niagara Railway Suspension Bridge, by John A. Roebling, C.E.

Mr. Allan having intimated that, in view of the possible extension of the contemplated Institute building on Pembroke Street, he proposed to add to his gift of a frontage on that street of ninety feet, a further donation of frontage northward of sixty-four feet.

It was resolved—That the Council gratefully accept of the valuable addition, and instruct the Secretary to record on the Minutes their cordial thanks for this further proof of his generous interest in the advancement of the Institute.

CANADIAN INSTITUTE BUILDING.

The attention of Members of the Institute is respectfully called to the Circular which will be found in the foregoing extracts from the Minutes of Council. The present position of the Canadian Institute is such as to warrant the Council in taking immediate steps for the erection of a suitable building, in which ample accommodation for a Museum, Reading Room, and Library of Reference may be provided. G. W. Allan, Esq., has increased his former valuable gift of a building site, 90 feet by 140, to one possessing a frontage on Pembroke Street of 154 feet and a depth of 140 feet. This munificent donation will allow of the construction of a building designed to admit of successive additions, as the means and material of the Society increase. The present number of names of members on the books of the Institute exceeds four hundred, and on the completion of several matters of detail, connected with the amalgamation of the Toronto Athenæum with the Institute, the Library of Reference will contain about fifteen hundred volumes. The progress of the Museum has been necessarily slow, owing to the state of uncertainty in which the Institute has been placed with respect to the necessary accommodation for the Models, Birds, Minerals, Geological Specimens, Insects, &c., already accumulated. The condition and prospects of the Institute being thus far extremely favorable, it is to be hoped that members will not allow the present valuable opportunity of giving material assistance to the building fund, to pass by unheeded.

Twenty-fifth Meeting of the British Association for the Advancement of Science.—Glasgow, 1855.

The Annual General Meeting for the present year of the members of the British Association, opened in the City of Glasgow on the 12th September, and continued until the following Monday (17th). The Members present included about 1200 Gentlemen and 500 Ladies. The Financial condition of the Association is represented as very favourable. The President's address was delivered in person by the Duke of Argyll. The next meeting is to be held in Cheltenham.

The following office-bearers were elected for the ensuing year: —*President*, G. R. Daubeny, M. D.; *Vice-Presidents*,, The Earl of Ducie, The Bishop of Gloucester, Sir Roderick I. Murchison, B. Baker, Esq., The Rev. F. Close; *Secretaries*, Capt. Robertson, R.A., R. Beamish, Esq., W. Hugall, Esq.; *Treasurers*, J. Webster, Esq., J. A. Gardner, Esq.

The following abstracts of papers read at the different Sections are from the *Athenæum*.

On the Cuneiform Inscriptions of Assyria and Babylonia, by Colonel Rawlinson.—Col. Rawlinson began by saying he feared the vastness, as well as to a great extent the novelty, of the subject would prevent him doing it anything like justice in the very limited time he had at his disposal. The excavations which had been carried on in Assyria and Babylonia had been continued through six or seven years—they had ranged over tracts of country 1,000 miles in extent—the marbles excavated would be sufficient to load three or four ships, and the historical information contained in them would exceed ten thousand volumes in clay. Of course, in dealing with such a subject he could only select a portion of it,—and even of that he could only communicate the heads. The part to which he wished to direct their attention was the Cuneiform Inscriptions. This phrase merely signified the wedged-shaped form of writing, and was not employed in any particular language or by one particular nation. The cuneiform system of letters was a species of picture-writing, invented, not by the Semitic inhabitants of Babylon, but by those who preceded them. This writing was, however, reduced by the Semitic race to letters, and adapted to the articulation of their language. Their mode of writing consisted of several elements. There was the ideographic, or picture-writing, and the phonetic, which was eqivalent to the alphabet of their language. He had been fortunately able to obtain among the ruins of Nineveh a tablet which actually exhibited the several developments of this system of writing into a regular alphabet. The cuneiform inscriptions were divided into three branches—Persian, Scythic, and Assyrian;—and it was on the third of these that he wished to say a few words. He then proceeded to explain how the decipherment of these inscriptions had been obtained. About twenty years ago his attention had been directed to a series of inscriptions in cuneiform characters on a rock at Behistûn, near Kermaixbah. The tablet was divided into three compartments, giving three different versions of the same inscription, and on the simplest of these, the Persian, he set to work, and found by comparing it with the two others that they corresponded, with the exception of two or three groups, from which, on further investigation, he made out—Hystaspes, Darius, and Xerxes. By means of these proper names he obtained an insight into the Persian alphabet, and by analyzing the names of the ancestors of Darius and Hystaspes, and obtaining a list of the tributary provinces of Persia, he managed to form the alphabet. This was, however, but the first step; the great object being to decipher the Assyrian inscription, and this could only be done by comparing it with the Persian. The tablet was situated on the face of the rock, 500 feet from the ground, with a precipice above it of 1,200 feet, and, in order to reach it, it was necessary to stand on the top rung of a ladder placed almost perpendicular. Nor was this all, for there was still the Babylonian to be copied, and it was engraved on the overhanging ledge of rock, which there was no means of reaching but by fastening tent-pegs into the rock, hanging a rope from one to the other, and, while thus swinging in mid-air, copying the inscription. An insight into the system of writing being thus obtained, the fortunate discovery of the ruins of Nineveh furnished a great mass of documents to which it might be applied. Wherever they had found tumuli, or any appearance of a ruin, trenches were sunk, galleries opened, and in almost every case they came upon the remains of inscribed tablets. Whether it was the king who wished to issue a bulletin, or a shopkeeper to make up his accounts, the same process had to be gone through of stamping it on clay tablets. The decipherment of these inscriptions led to important results in an ethnological point of view, both as indicating the race to which the writers belonged, and affording important information with reference to the habitat of races and their migrations. Among the many points which they were now enabled satisfactorily to settle, he alluded to the connexion between the Turanian and Hamic families, and to the occupation of Western Asia by the Scythic, and not the Semitic race. He also mentioned that from the inscriptions he believed it would be shown that the Queen of Sheba came from Idumea. As to the advantages conferred on geography by these discoveries, he would not attempt to give in detail the ramifications of geographical knowledge which had been thus obtained. He would proceed to the most interesting and important branch of the subject, the historical. An erroneous impression was at one time in circulation that the information obtained from the inscriptions was adverse to Scripture. But so much was it the reverse of this, that if they were to draw up a scheme of chronology from the inscriptions, without having seen the statements of the Scriptures, they would find it coincide on every important point. The excavations at Chaldea furnished them with inscriptions showing the names of kings, their parentage, the gods they worshipped, the temples they built, the cities they founded, and many other particulars of their reign. He then mentioned some circumstances with reference to the mound at Birs-Nimroud, which he had recently uncovered, and which he found laid out in the form of seven terraces. These were arranged in the order in which the Caldeans or Sabeans supposed the planetary spheres were arranged, and each terrace being painted in different colours, in order to represent its respective planet. Another curious circumstance with reference to this excavation was the discovery of documents enclosed in this temple. From the appearance of the place, he was enabled at once to say in what part they were placed, and on opening the wall at the place he indicated, his workmen found two fine cylinders. He also mentioned another small ivory cylinder which he had discovered, and round which were engraved mathematical figures, so small that they could hardly be seen with the naked eye, and which could not have been engraved without the aid of a very strong lens. In concluding, he said that before the British Association met next year, he hoped to be able to bring before them the decipherment of several highly important inscriptions.

On the less-known Fossil Floras of Scotland, by Mr. HUGH MILLER.—Scotland has its four fossil Floras: its Flora of the Old Red Sandstone, its carboniferous Flora, its oolitic Flora, and that Flora of apparently tertiary age, of which His Grace the Duke of Argyll found so interesting a fragment, overflown by the thick basalt beds and trap tuffs of Mull. Of these, the only one adequately known to the geologist is the gorgeous Flora of the coal-measures, probably the richest, in at least individual plants, which the world has yet seen. The others are all but wholly unknown; and the Association may be the more disposed to tolerate the comparative meagreness of the few brief remarks which I propose making on two of their number—the Floras of the Old Red Sandstone and the oolite—from the consideration that the meagreness is only too truly representative of the present state of our knowledge regarding them, and that if my descriptions be scanty and inadequate, it is only because the facts are still few. How much of the lost may yet be recovered I know not; but the circumstances that two great Floras—remote predecessors of the existing one—that once covered with their continuous mantle of green the dry land of what is now Scotland, should be represented but by a few coniferous fossils, a few cycadaceous fronds, a few ferns and club mosses, must serve to show what mere fragments of the past history of our country we have yet been able to recover from the rocks, and how very much in the work of exploration and discovery still remains for us to do. We stand on the further edge of the great Floras of by-past creations, and have gathered but a few handfuls of faded leaves, a few broken branches, a few decayed cones. The Silurian deposits of our country have not yet furnished us with any unequivocal traces of a terrestrial vegetation. Prof. Nicol, of Aberdeen, on subjecting to the microscope the ashes of a silurian anthracite which occurs in Peebles-shire, detected in it minute tubular fibres, which seem, he says, to indicate a higher class of vegetation than the algæ; but these may have belonged to a marine vegetation notwithstanding. Associated with the earliest ichthysic remains of the Old Red Sandstone, we find vegetable organisms in such abundance, that they communicate often a fissile character to the stone in which they occur. But, existing as mere carbonaceous markings, their state of keeping is usually so bad, that they tell us little else than that the antiquely-formed fishes of this remote period had swam over sea-bottoms darkened by forests of algæ. The immensely developed flagstones of Caithness seem to owe their dark colour to organic matter, mainly of vegetable origin. So strongly bituminous, indeed, are some of the beds of dingier tint, that they flame in the fire like slates steeped in oil. The remains of terrestrial vegetation in this deposite are greatly scantier than those of its marine Flora; but they must be regarded as possessing a peculiar interest, as the oldest of their class in, at least, the British Islands, whose true place in the scale can be satisfactorily established. In the flagstones of Orkney there occurs, though very rarely, a minute vegetable organism, which I have elsewhere described as having much the appearance of one of our smaller ferns, such as the maidenhair spleenwort or dwarf moonwort. But the vegetable organism of the formation, indicative of the highest rank of any yet found in it, is a true wood of the cone-bearing order. I laid open the nodule which contains this specimen, in one of the ichthyolite beds of Cromarty, rather more than eighteen years ago; but, though I described it, in the first edition of a little work on 'The Old Red Sandstone' in 1841, as exhibiting the woody fibre, it was not until 1845 that, with the assistance of the optical lapidary, I subjected its structure to the test of the microscope. It turned out, as I anticipated, to be the portion of a tree; and on my submitting the prepared specimen to one of our highest authorities, the late Mr. William Nicol, he at once decided that the "reticulated texture of the transverse section, though somewhat compressed, clearly indicated a coniferous origin." I may add, that this most ancient of Scottish lignites presented several peculiarities of structure. Like some of the Araucarians of the warmer latitudes, it exhibits no lines of yearly growth; its medullary rays are slender, and comparatively inconspicuous; and the discs which mottle the sides of its sap chambers, when viewed in the longitudinal section, are exceedingly minute, and are ranged, so far as can be judged in their imperfect state of keeping, in the alternate order peculiar to the Araucarians. On what perished land of the early Palæozoic ages did this venerably antique tree cast root and flourish, when the extinct genera Pterichthys and Coccosteous were enjoying life by millions in the surrounding seas—long ere the Flora or Fauna of the coal measures had begun to be? The Caithness flagstones have furnished one vegetable organism apparently higher in the scale than those just described, in a well-marked specimen of Lepidodendron, which exhibits. like the Araucacarian of the Lower Old Red, though less distinctly, the internal structure. It was found about sixteen years ago in a pavement quarry near Clockbriggs—the last station on the Aberdeen and Forfar railway—as the traveller approaches the latter place from the north. Above this grey flagstone formation lies the Upper Old Red Sandstone, with its peculiar group of ichthyic organisms, none of which seem specifically identical with those of either the Caithness or the Forfarshire beds; for it is an interesting circumstance, suggestive surely of the vast periods which must have elapsed during its deposition, that the great Old Red system had its three distinct platforms of organic existence, each wholly different from the others. Generically and in the group, however, the Upper fishes much more closely resemble the fishes of the Lower, or Caithness and Cromarty platform, than they do those of the Forfarshire and Kincardine one. In the uppermost beds of the Upper Old Red formation in Scotland, which are usually of a pale or light yellow colour, the vegetable remains again become strongly carbonaceous, but their state of preservation continues bad—too bad to admit of their determination of either species or genera; and not until we rise a very little beyond the system do we find the remains of a Flora either rich or well preserved. But very remarkable is the change which at this stage at once occurs. We pass at a single stride from great poverty to great wealth. The suddenness of the change seems suited to remind one of that experienced by the voyager when, after traversing for many days some wide expanse of ocean, unvaried save by its banks of floating sea-weed, or where, occasionally and at wide intervals, he picks up some leaf-bearing bough, or marks some fragment of drift-weed go floating past, he enters at length the sheltered lagoon of some coral island, and sees all around the deep green of a tropical vegetation descending in tangled luxuriance to the water's edge—tall, erect ferns, and creeping Lycapodaceæ; and the pandanus, with its aerial roots and its screw-like clusters of narrow leaves; and high over all, tall palms, with their huge pinnate fronds, and their curiously aggregated groups of massive fruit. In this noble Flora of the coal-measures much still remains to be done in Scotland. Our Lower Carboniferous rocks are of immense development; the limestones of Burdie House, with their numerous terrestrial plants, occur many hundred feet beneath our mountain limestones; and our list of vegetable species peculiar to these lower deposits is still very incomplete. Even in those higher carboniferous rocks with which the many coal workings of the country have rendered us comparatively familiar, there seems to be still a good deal of the new and the unknown to repay the labour of future explorers. It was only last year that Mr. Gourlie, of this city, added to our fossil Flora a new Volkmannia from the coal-field of Carluke; and I detected very recently in a neighbouring locality, though in but an indifferent state of keeping, what seems to be a new and very peculiar fern. There is a Stigmaria, too, on the table, very ornate in its sculpture, of which I have now found three specimens in a quarry of the coal-measures near Portobello, that has still to be figured and described. In this richly-ornamented Stigmaria the characteristic areolæ present the ordinary aspect; each, however, forms the centre of a sculptured star, consisting of from eighteen to twenty rays, or rather the centre of a sculptured flower of the Composite order, resembling a garden daisy. The minute petals—if we are to accept the latter comparison—are ranged in three concentric lines, and their form is irregularly lenticular. Even among the vegetable organisms already partially described and figured, much remains to be accomplished in the way of restoration. The detached pinnæ of a fern, or a few fragments of the stems of Ulodendron or Sigillaria, give every inadequate ideas of the plants to which they had belonged in their state of original entireness.

Experimental Observations on an Electric Cable, by Mr. WILDMAN WHITEHOUSE.—After referring to the rapid progress in submarine telegraphy which the last four years have witnessed, Mr. Whitehouse said that he regarded it as an established fact that the nautical and engineering difficulties which at first existed had been already overcome, and that the experience gained in submerging the shorter lengths had enabled the projectors to provide for all contingencies affecting the greater. The author then drew the attention of the Section to a series of experimental observations which he had recently made upon the Mediterranean and Newfoundland cables, before they sailed for their respective destinations. These cables contained an aggregate of 1,125 miles of insulated electric wire,—and the experiments were conducted chiefly with reference to the problem of the practicability of establishing electric communications with India, Australia, and America. The results of all the experiments were recorded by a steel style upon electro-chemical paper by the action of the current itself, while the paper was at the same time divided into seconds and fractional parts of a second by the use of a pendulum. This mode of operating admits of great delicacy in the determination of the results, as the seconds can afterwards be divided into hundredths by the use of a "vernier," and the result read off with the same facility as a barometric observation. Enlarged fac-similes of the electric autographs, as the author calls them, were exhibited as diagrams, and the actual slips of electro-chemical paper were laid upon the table. The well-known effects of induction upon the current were accurately displayed; and contrasted with these were other autographs showing the effect of forcibly discharging the wire by giving it an adequate charge of the opposite electricity in the mode proposed by the author. No less than eight currents—four positive and four negative—were in this way transmitted in a single second of time through the same length of wire (1,125 miles) through which a single current required a second and a half to discharge itself *spontaneously* upon the paper. Having stated the precautions adopted to guard against error in the observations, the details of the experiments were then concisely given, including those for "velocity," which showed a much higher rate attainable by the magneto-electric than by the voltaic current. The author then recapitulated the facts, to which he specially invited attention:—First, the mode of testing velocity by the use of a voltaic current divided into two parts (a split current), one of which shall pass through a graduated resistance tube of distilled water, and a few feet only of wire, while the other part shall be sent through the long circuit, both being made to record themselves by adjacent styles upon the same slip of electro-chemical paper. Second, the use of magneto-electric "twin-currents," synchronous in their origin, but wholly distinct in their metallic circuits, for the same purpose, whether they be made to record themselves direct upon the paper, or to actuate relays or receiving instruments which shall give contacts for a local printing battery. Third, the effects of induction, retardation of the current, and charging of the wire, as shown autographically; and contrasted with this—fourth, the rapid and forcible discharging of the wire by the use of an opposite current; and hence—fifth, the use of this as a means of maintaining, or restoring at pleasure, the electric equilibrium of the wire. Sixth, absolute neutralization of currents by too rapid reversal. Seventh, comparison of working speed attainable in a given length of wire by the use of repetitions of similar voltaic currents as contrasted with alternating magneto-electric currents, and which, at the lowest estimate, seemed to be seven or eight to one in favour of the latter. Eighth, proof of the co-existence of several waves of electric force of opposite character in a wire of given length, of which each respectively will arrive at its destination without interference. Ninth, the velocity, or rather amount of retardation, greatly influenced by the energy of the current employed, other conditions remaining the same. Tenth, no adequate advantages obtained in a 300-mile length by doubling or trebling the mass of conducting metals. The author, in conclusion, stated his conviction that it appeared from these experiments, as well as from trials which he had made with an instrument of the simplest form, actuated by magneto-electric currents, that the working speed attainable in a submarine wire of 1,125 miles was ample for commercial success. And may we not, he added, fairly conclude also that India, Australia, and America, are accessible by telegraph without the use of wires larger than those commonly employed in submarines cables?

Remarks on the Chronology of the Formations of the Moon, by Prof. NICHOL.—Prof Nichol stated that, through the munificence of the Marquis of Breadalbane, he had been enabled to bring to bear on the delicate inquiries, whose commencement he intended to explain, a very great if not a fully adequate amount of telescopic power. A speculum of twenty-one inches, originally made by the late Mr. Ramage with the impracticable focal length of *fifty-five feet*, had, at the expense of that noble Lord, been re-ground, polished, mounted as an equatoreal, and placed in the Glasgow Observatory, in its best state only about six weeks ago. Prof. Nichol showed some lunar photographs, which indicated the great light with which the telescope endowed its focal images, and entered on other details as to its *definition*. The object of the present paper is the reverse of speculative. It aims to recall from mere speculation, to the road towards positive inquiry, all observers of the lunar surface. To our satellite hitherto those very ideas have been applied, which confused the whole early epochs of our terrestrial geology, the notion, viz., that its surface is a *chaos*, the result of primary, sudden, short-lived and lawless convulsion. We do not now connect the conception of irregularity with the history of the earth:—it is the triumph of science to have analyzed that apparent chaos, and discerned order through it all. The mode by which this has been accomplished, it is well known, has been the arrangement of our terrene mountains according to their relation to time: their relative ages determined, the course of our world seemed smooth and harmonious, like the advance of any other great organization. Ought we not then to attempt to apply a similar mode of classification to the formations in the moon,—hoping to discern there also a course of development, and no confusion of manifestation of irregular convulsion? Prof. Nichol then attempted to point out that there appeared a practical and positive mode by which such classification might be effected. It could not, in so far as he yet had discerned, be accomplished by tracing, as we had done on earth, relations between lunar upheavals and stratified rocks; but another principle was quite as decisive in the information it gave, viz., the intersection of dislocations. There are clear marks of dislocation in the moon—nay, the surface of our satellite is overspread with them. These are the rays of light, or rather bright rays, that flow from almost all the great craters as their centres, and are also found where craters do not at present appear. Whatever the substance of this highly reflecting matter, it is evidently no superficial layer or stream, like lava, but extends downwards a considerable depth into the body of the moon. In short, we have no likeness to it on earth, in the sense now spoken of, except our great trap and crystalline *dykes*. It seemed clear, then, that the intersection of these rays are really *intersections of dislocations*, from which we might deduce their chronology. Can the intersection, however, be sufficiently seen?—in other words, is the telescope adequate to determine which of the two intersecting lines has disturbed or cut through the other? Prof. Nichol maintained the affirmative in many cases, and by aid of diagrams, taken down from direct observation, illustrated and enforced his views.

Note on Solar Refraction, by Prof. PIAZZI SMYTH.—Amongst other interesting and important consequences of the dynamical theory of heat, Prof. W. Thomson having deduced the necessity of a resisting medium, the condensation of this about the sun, and a consequent refraction of the stars seen in that neighbourhood, Prof. Piazzi Smyth had endeavoured to ascertain by direct astronomical observation whether any such effect was sensible to our best instruments. Owing to atmospheric obstructions, only three observations, yielding two results, had been yet obtained; but both these indicated a sensible amount of solar refraction. Should this effect be confirmed by more numerous observations, it must have important bearings on every branch of astronomy; and as the atmosphere at all ordinary observatories presents almost insuperable obstacles, the author pointed out the advantage of stationing a telescope for this purpose on the summit of a high mountain.

ERRATUM.—The Lithographer of the Map of the Township of Colchester, which accompanied the conclusion of Major Lachlan's paper in the last number of the Journal, has introduced an error in the direction of one of the Canoe Canals, which we take this opportunity of rectifying. Instead of running straight through Round Marsh and Long Marsh, it should run due north along the borders of Long Marsh as far as the 8th Concession, and then across *Roach's Marsh only*, until it approached the River Canard. A drain from Round Marsh into the Canoe Canal will accomplish all that is required with respect to the drainage of Round Marsh.

Monthly Meteorological Register, at the Provincial Magnetical Observatory, Toronto, Canada West.—August, 1855.

Latitude, 43 deg. 39.4 min. North. Longitude, 79 deg 21. min. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32 deg. 6 A.M.	2 P.M.	10 P.M.	Mean.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	M'N.	Mean Temp. + or — of the Average	Tension of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humid'y of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Wind. 6 A.M.	2 P.M.	10 P.M.	Mean Direct.	Mean Vel'y	Rain in Inch.
1	29·701	29·683	29·682	29·686	68·7	73·7	67·8	70·9	+ 3·9	0·586	0·674	0·559	0·603	·87	·84	·85	·83	N b E	E b S	Calm	E 26 N	4·12	...
2	·716	·719	·721	·715	67·8	79·0	69·3	71·8	+ 4·9	·556	·642	·642	·627	85	67	92	83	N E b N	E b S	N b E	E 13 S	4·78	...
3	·750	·701	·618	·685	67·5	82·1	69·7	74·7	+ 7·8	·596	·711	·600	·665	92	67	85	81	N b W	S	S W	W 17 S	4·74	0·015
4	·619	·567	·595	·593	71·4	75·1	70·4	72·8	+ 5·9	·668	·738	·644	·681	89	87	89	87	W b N	S	E b N	S 10 E	4·15	0·380
5	·591	·526	—	—	63·7	73·7	—	—	—	·478	·526	—	—	84	66	—	—	N N E	E b S	N W b N	N 17 E	6·14	...
6	·529	·564	·611	·575	62·1	76·2	65·7	68·8	+ 2·0	·416	·500	·516	·469	76	57	84	70	N b W	S b W	N	N 43 W	6·83	...
7	·593	·618	·801	·673	56·8	72·7	61·7	65·3	— 1·4	·410	·556	·387	·434	91	71	72	72	N W	N E	E b N	E 32 N	9·47	0·020
8	·748	·540	·294	·501	61·6	68·6	67·1	65·6	— 1·1	·433	·482	·616	·509	82	72	96	83	S E b E	E	E S E	E 12 N	7·88	0·095
9	·143	·167	·295	·204	72·0	75·3	63·5	69·8	+ 3·1	·678	·488	·456	·510	89	58	80	73	S W	W	W	W 2 N	16·95	...
10	·417	·491	·582	·502	57·8	67·2	56·4	60·8	— 5·7	·347	·364	·282	·320	74	56	64	62	W	W b N	N b W	W 36 N	8·21	...
11	·639	·669	·650	·658	54·6	68·6	62·1	62·7	— 3·7	·311	·444	·463	·432	74	66	85	77	N E	E S E	E b N	E 11 S	6·79	...
12	·685	·680	—	—	64·9	72·1	—	—	—	·524	·787	—	—	87	97	—	—	N E b E	S b W	W	W 11 N	6·34	0·615
13	·777	·777	·802	·786	62·5	76·1	60·3	66·1	— 0·1	·428	·524	·275	·408	77	60	53	63	N N W	N W	N W b N	N 40 W	6·67	...
14	·837	·800	·762	·798	61·8	70·4	61·5	64·4	— 1·8	·284	·514	·389	·395	53	72	73	67	N N W	S	N	N 9 W	5·27	...
15	·715	·492	·447	·533	54·2	75·2	68·6	67·8	+ 1·6	·868	·533	·573	·517	89	63	85	78	N b E	S b E	S W	S 17 E	5·13	0·295
16	·366	·356	·428	·377	65·0	80·1	63·5	69·1	+ 3·1	·559	·594	·354	·497	93	59	62	71	S W b S	S W b W	N W	W 17 N	9·06	Inap.
17	·424	·502	·714	·560	56·4	64·8	51·1	56·9	— 9·0	·264	·218	·289	·260	59	36	79	59	W b N	W	W	W	15·45	0·035
18	·808	·875	·927	·878	47·0	62·6	50·6	53·9	—11·9	·267	·271	·264	·263	84	49	72	66	W N W	N W b W	N b W	W 35 N	8·39	...
19	30·019	·936	—	—	45·6	62·5	—	—	—	·231	·360	—	—	77	65	—	—	N N W	S E b S	E	E 42 S	4·45	...
20	29·915	·841	·797	·846	53·5	72·5	60·3	61·7	— 8·8	·315	·488	·447	·409	78	63	87	76	N b E	S S E	S S W	S 6 E	4·92	...
21	·777	·707	·711	·730	55·6	77·2	62·1	66·5	+ 1·0	·410	·551	·496	·493	95	60	91	79	N E	S	S S W	S 13 W	6·90	...
22	·714	·648	·577	·641	60·1	70·4	63·9	65·6	+ 0·3	·464	·534	·517	·513	91	71	89	84	Calm.	E b S	E b N	E 8 S	3·71	...
23	·508	·460	·508	491	62·5	71·9	61·4	64·0	— 0·8	·513	·605	·384	·507	94	80	72	84	N b E	S W	N N W	N 44 W	3·88	...
24	·552	·565	·611	·581	54·6	73·9	61·4	64·6	— 0 4	·310	·435	·459	·420	74	58	80	72	W b N	S	S b W	S 10 W	5·74	...
25	·707	·676	·623	·665	58·9	72·7	63·2	65·6	+ 0·8	·425	·499	·529	·487	87	64	94	[illegible]	S S W	E b S	Calm	E 11 S	3·61	...
26	·610	·739	—	—	61·2	66·8	—	—	—	·483	·455	—	—	91	71	—	—	Calm.	N N W	N b E	N 14 W	9·94	...
27	·942	·875	·823	·875	48·5	59·7	48·8	52·9	—11·4	·215	·269	·273	·256	64	54	80	65	N b E	E S E	N b W	E 42 N	7·88	...
28	·810	·770	·687	·758	46·7	65·3	49·2	55·5	— 8·6	·235	·318	·302	·290	74	52	88	69	N	S b E	S E	S 42 E	4·62	...
29	·604	·446	·603	·566	45·9	68·2	60·7	60·9	— 3·0	·276	·523	·378	·395	90	78	72	75	W	S S W	N W	E 5 S	11·68	Inap.
30	·856	·879	·937	·897	50·4	62·2	50·6	54·2	— 9·4	·291	·290	·271	·274	81	53	75	67	N b W	S b E	N	N 6 W	7·54	...
31	·970	·941	·752	·865	47·9	61·1	55·3	56·1	— 7·2	·267	·361	·396	·352	81	68	93	79	N E b N	E S E	E b N	E 12 N	4·64	Inap.
M	29·672	29·642	29·650	29·653	58·2	71·2	61·0	64·1	— 1·7	0·403	0·486	0·436	0·444	·82	·64	81	·74	5·22	10·25	5·06	W 27 N	6·97	1·455

Highest Barometer...... 30·019, at 6 a.m. on 19th } Monthly range:
Lowest Barometer....... 29·130, at 8 a.m. on 9th } 0·889 inches.

Highest registered temperature 83°·5, at p.m., 3rd } Monthly range:
Lowest registered temperature 40°·0, at a.m. on 19th } 43°·5.

Mean Maximum Thermometer.............. 74°·61 } Mean daily range:
Mean Minimum Thermometer....... ...... 54°·09 } 20.52

Greatest daily range.........34°·2, from p.m. of 16th to a.m. of 17th.
Least daily range ....8°·8, from p.m. of 8th, to a.m. of 9th.

Warmest day....... 3rd. Mean temperature......74°·67 } Difference,
Coldest day......... 27th. Mean temperature......52°·93 } 21°·74.

Greatest intensity of Solar Radiation, 98°·4 on p.m. of 4th } Range,
Lowest point of Terrestrial Radiation, 30°·2 on a. m. of 19th } 68°·2.

Aurora observed on 5 nights: viz. on 4th, 14th, 17th, 18th and 23rd.
Possible to see Aurora on 24 nights. Impossible on 7 nights.
Raining on 7 days. Raining 8·1 hours; depth, 1·455 inches.
Mean of Cloudiness, 0· 44.
Thunder storms occurred on the 4th, 16th, and 31st.
Sheet lightning observed on the 8th and 15th.
In observing for the periodic appearance of Meteors considerable numbers were noted on the nights of the 11th and 13th.

Sum of the Atmospheric Current, in miles, resolved into the four Cardinal directions.

North.	West.	South.	East.
1795·01	1899·31	1443 32	1208·52

Mean direction of Wind, W 27° N. Mean velocity 6·97 miles per hour.
Maximum velocity, 32·6 miles per hour, from 1 to 2 p.m. on 17th.
Most windy day, the 9th; mean velocity, 16·95 miles per hour.
Least windy day, the 22nd; mean velocity, 3·71 " "
Most windy hour, 1 p.m.; Mean velocity, 10·47 miles per hour.
Least windy hour, 1 a.m.; Mean velocity, 4·78 " "
Mean diurnal variation, 5·69 miles.

16th. 5·30 to 6·20 a.m., violent *Thunderstorm,* the quantity of rain which fell in this storm was 0·295 inch. on the surface, and the velocity of the wind, from 6·12 to 6.18 a.m. attained the rate of 75·0 miles per hour.

17th. 6·45 to 7·05 p.m. very perfectly defined double *Rainbow,* beautifully exhibiting the prismatic colours.

26th. 7·54 p.m. a *Meteor* about three times as large as Jupiter observed in S.W., leaving a train of light behind it, which lasted fully a minute after the disappearance of the meteor.

The Mean Temperature of this month has been 2°·1 below the average, and the quantity of Rain has been less than the Mean by 1·264 inch. on the surface, whilst the velocity of the Wind has been in excess of the average by 2·39 miles per hour. The month may therefore be characterized as cold, clear, dry and windy.

Comparative Table for August.

YEAR.	Temperature. Mean.	Dif. from Av'ge	Max. obs'vd	Min. obs'vd	Range	Rain. D's.	Inch.	Wind M'n Direc.	Mean Velocity in Miles	
1840	64·7	—1·5	80·1	47·4	32·7	12	2·905	...	...	
1841	64·4	—1·8	83·5	46·7	36 8	9	6·170	...	0·19	lbs.
1842	65·7	—0·5	80·7	45·3	35·4	6	2·500	...	0·30	lbs.
1843	66·4	+0·2	85·5	44·4	41·1	4	4·850	...	0·12	lbs
1844	64·3	—1·9	82·5	44·3	38·2	17	impt.	...	0·16	lbs.
1845	67·9	+1·7	82·5	44·4	38·1	9	1·725	...	0·19	lbs.
1846	68·4	+2·2	86·3	50·4	35·9	9	1·770	...	0·17	lbs.
1847	65·1	—1·1	83·1	44·9	38·2	10	2·140	...	0·19	lbs.
1848	69·2	+3·0	87·5	49·3	38·2	8	0·855	S 20 E	4·55	Miles.
1849	66·3	+0·1	79·5	51·4	28·1	10	4·970	W 19 N	3·76	Miles.
1850	66·8	+0·6	84·2	43·0	41·2	13	4·355	N 15 E	4·46	Miles.
1851	63·6	—2·6	79·8	43·6	36·2	10	1·360	W 27 N	4·62	Miles.
1852	65·9	—0·3	81·2	46·7	34·5	9	2·695	E 20 N	3·30	Miles.
1853	68·6	+2·4	91·6	47·6	44·0	11	2·575	S 29 E	4·23	Miles.
1854	68·0	+1·8	98·1	47·0	51·1	5	0·455	W 28 N	4·74	Miles.
1855	64·1	—2·1	82·1	44·9	37·2	7	1·455	W 27 N	6·97	Miles.
									0·19	lbs.
M'n.	66·21		84·26	46·33	37·93	9.3	2·719		4·58	Miles.

Monthly Meteorological Register, St. Martin, Isle Jesus, Canada East.—August, 1855.

NINE MILES WEST OF MONTREAL.

BY CHARLES SMALLWOOD, M.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 Feet.

Day.	Barom. corrected and reduced to 32° Fahr.			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Velocity in Miles per Hour.			Rain in	Weather, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	Inches	6 A.M.	2 P.M.	10 P.M.
1	29.974	29.826	29.959	68.9	89.0	68.6	.496	·617	·552	·72	·46	·81	N E	N E b E	E N E	0·00	3·01	0·95	...	Clear.	Clear.	Cum. Str. 4.
2	30.010	.911	.955	66.5	93.4	74.0	555	607	648	89	41	78	N E b E	S	S W	2·19	0·37	0·62	...	Do.	Do.	Str. 2.
3	29.970	.929	.817	73.9	89.4	73.9	692	751	692	86	56	85	S W	S W	S W	3·17	3·67	4·28	...	Do.	Str. 2.	Cum. Str. 2.
4	.685	.712	.868	72.0	82.1	68.0	670	692	496	86	64	72	W	N E	N E	5·02	2·97	10·08	...	Cir. Cum. Str.	Cum. Str. 2.	Do. 2.
5	.781	.760	.702	60.0	82.0	62.8	312	727	445	81	68	79	N E	S W b S	S W b S	0·16	0·53	Inap.	...	Clear. [10.	Do. 4.	Clear, ft. aurora.
6	.782	.705	.816	66.2	78.6	59.7	372	473	358	84	60	71	N b E	W S W	N W b W	2·67	1·34	5·63	...	Do.	Do. 2.	Do.
7	.850	.824	.916	54.3	68.0	52.1	349	646	349	81	94	87	N W b N	N E b E	N E b N	Inap.	Inap.	Calm	0·436	Cirr. Str. 8.	Rain.	Do.
8	30.000	.994	.690	51.2	69.9	60.1	301	461	441	93	65	84	W S W	S b E	S b E	Inap.	0·42	4·02	...	Clear.	Cir. Cum. Str. 4.	Str. 10.
9	29.301	.199	.201	62.1	66.0	66.0	546	615	680	99	95	90	S	W b N	W b S	9·62	3·61	4·50	0·530	Rain.	Rain with Thun.	Do. 8.
10	.369	.495	.700	68.0	65.0	52.2	346	449	319	70	72	87	W	W N W	N W b W	15·62	14·18	10.31	...	Clear.	Cir. Cum. Str. 5.	Clear, ft. aurora.
11	.896	.909	.952	60.0	80.4	61.1	421	532	456	80	53	84	W N W	S	S E	0·38	0·21	0·14	...	Do.	Cum. Str. 2.	Str. 2, do. do.
12	.966	.907	.854	64.7	81.1	68.8	476	670	613	79	64	89	S	S b E	S E	Inap.	2·26	2·06	Inapp.	Cir. Str. 4.	Do. 6.	Str. 10.
13	.844	.812	.904	66.1	79.4	64.4	621	628	476	99	64	79	N W b W	W	W	2·00	3·93	5·15	0·876	Cum. Str. 4.	Clear.	Do. 8.
14	30.001	30.012	30.023	52.2	76.4	56.9	357	568	363	89	64	79	W N W	W b N	W b N	Inap.	8·37	Calm	...	Clear.	Do.	Clear.
15	29.945	29.733	29.651	45.3	82.4	67.4	292	568	626	93	53	98	W b N	S b E	N W b W	Calm	4·30	2·18	0·233	Do.	Cir. Cum. Str. 4.	Rain.
16	.560	.462	.524	70.1	83.1	73.0	628	787	692	86	71	86	S S W	W S W	S W b W	0·93	5·00	4·93	0·856	Str. 4.	Cum. Str. 4, thu.	Do.
17	.491	.480	.696	65.4	74.3	55.0	555	481	31?	89	58	70	W b S	S W	W	2·01	7·50	13·50	0·950	Cirr Str. 6.	Do. 2.	Cir.Str.4,ft.A.B.
18	.894	.927	30.031	52.7	64.0	50.6	304	363	326	76	61	87	W	W	W	11·23	11·21	6·14	Inapp.	Cirr. 2.	Do. 4.	Clear.
19	30.121	30.090	30.123	43.2	71.6	55.6	272	458	372	92	60	84	W	S W	W S W	Inap.	3·62	2·31	...	Clear, Frost.	Cir. 2.	Do.
20	30.062	30.122	30.007	53.1	76.6	63.0	352	541	491	83	61	85	S W b S	W S W	S W b W	1·05	4·33	3·50	...	Cum. Str. 4	Clear.	Cum. Str. 4.
21	29.912	29.860	29.881	63.6	83.2	70.6	516	715	568	89	64	78	W S W	W S W	S W	0·83	7·50	8·50	...	Clear.	Do.	Do. 4.
22	.928	.857	.847	67.6	79.2	64.6	593	692	565	89	71	94	S W	N W b W	N E	Calm	1·68	3·68	...	Cum Str. 9.	Cir. Cum. Str. 9.	Do. 10.
23	.693	.688	.629	64.1	81.7	68.6	576	704	646	96	68	94	N E	W S W	W b S	0·75	Inap.	0·21	...	Fog.	Cum. Str. 6.	Do. 4, Aur. B.
24	.672	.680	.800	66.1	82.2	64.0	526	660	373	82	62	87	W b S	S S W	N W	Inap.	1·35	5·39	...	Clear.	Do. 6.	Clear.
25	.983	.907	.916	60.6	80.5	63.4	467	617	488	89	61	84	E N E	E b S	E b N	2·12	2·01	1 11	...	Do.	Clear.	Cir. Str. 4.
26	.714	.815	30.090	70.6	75.2	51.5	541	523	274	74	61	71	S S W	W N W	N	4·00	13·90	8·31	0·173	Do.	Cum. Str. 4, thu.	Light Cum. 2.
27	30.193	30.089	30.048	40.5	67.4	43.5	227	366	272	86	55	90	N N E	E N E	S	4·06	3·10	Calm	...	Clear, Frost.	Clear.	Clear.
28	30.028	29.938	29.916	36.0	73.4	56.0	192	489	385	83	61	84	S b E	S	S b W	Calm	0·25	0·19	...	Do. do.	Do.	Do.
29	29.721	.624	.561	54.5	70.0	61.0	373	568	511	87	78	94	S b W	W b S	N W b W	Calm	7·74	9·40	...	Do.	Cir. Str. 7.	Rain.
30	.954	.960	30.049	47.0	57.1	40.1	252	249	241	74	52	88	N W b W	N W b W	N W b W	6·29	12·31	9·12	0·170	Do.	Cir. Cum. 4.	Clear.
31	30.199	30.083	30.067	39.4	65.3	52.6	234	361	349	91	58	87	N W b W	W b S	S W	Calm	0·84	0·78	0·142	Do.	Cir. Cum. Str. 4.	Rain.

Barometer ....
- Highest, the 31st day .... 30·199
- Lowest, the 9th day .... 29·199
- Monthly Mean .... 29·862
- " Range .... 1·000

Thermometer
- Highest, the 2d day .... 97°·0
- Lowest, the 31st day .... 32°·2
- Monthly Mean .... 64°·91
- " Range .... 64°·8
- Mean Humidity .... ·773

Greatest Intensity of the Sun's Rays .... 132°·8
Lowest Point of Terrestrial Radiation .... 30°·2
Amount of Evaporation, 3 80 inches.

Rain fell on 11 days, amounting to 4·366 inches, and was accompanied by thunder on three days. Raining 34 hours. 40 minutes.
First Frost on the 19th day.
Most prevalent Wind, W. Least prevalent Wind, S b E.
Most Windy Day, the 10th day; mean miles per hour, 13·87.
Least Windy Day, the 7th; mean miles per hour, 0.00.
Aurora Borealis visible on 5 nights. Might have been seen on 20 nights.

The electrical state of the atmosphere has been marked by a moderate intensity of a positive character; and during the storms of thunder indicated a negative character.
Ozone.—The amount of Ozone was in rather large quantity during the month.
The Temperature of the month was 3°·37 lower than that of last August, and the monthly range was also 16°6 minus that of last August.