Technical and Bibliographic Notes / Notes techniques et bibliographiques

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

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

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

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

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

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

- [ ] Additional comments:/ Commentaires supplémentaires:

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

| 10X | 12X | 14X | 16X | 18X | 20X | 22X | 24X | 26X | 28X | 30X | 32X |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ✓ | | | | |

THE

# CANADIAN

# Naturalist and Geologist,

AND PROCEEDINGS OF THE

# NATURAL HISTORY SOCIETY

OF MONTREAL.

CONDUCTED BY A COMMITTEE OF THE NATURAL HISTORY SOCIETY.

VOLUME VIII.

Montreal:
PUBLISHED BY DAWSON BROTHERS, 23 GREAT ST. JAMES STREET,
1863.

# CANADIAN NATURALIST.

This Magazine is published bi-monthly, and is conducted by a Committee of the Natural History Society of Montreal.

## CIRCULAR OF THE COUNCIL OF THE MONTREAL NATURAL HISTORY SOCIETY.

The Council of the Natural History Society of Montreal have still to deplore the very defective state of their collection of mammals. The recent large increase of the working members of the Society, its improved status at home and reputation abroad, and the removal of the Society to their present commodious building, all demand that this collection should attain the same completeness as that of the Canadian birds, now in the Museum, and become equally useful for reference. The Council would therefore respectfully represent to Naturalists, Sportsmen and others, that they could much advance the desired object by sending their specimens to the Society for preservation; and to those kindred Societies who might also feel disposed to co-operate, the duplicate specimens of minerals, fossils, and birds, both American and foreign, now in possession of the Society, would readily be made available where wanted. In publishing the subjoined list of quadrupeds chiefly wanted, the Council desire to solicit the aid of the public generally to supply them, convinced that their efforts to foster and advance the special branch of science to which they devote themselves, will be appreciated.

ABRAHAM DE SOLA, LL.D.,
*Chairman.*

JOHN LEEMING,
*Recording Secretary.*

Montreal, January, 1863.

---

Lynx Canadensis, or Common American Wildcat.
Lynx Fasciatus.
Parry's Marmot Squirrel.
Four-striped Ground Squirrel.
The Wolverine.
Collared Peccary.
Red-bellied Squirrel.
Canada Pouched Rat.
Black Spermophile.
Douglas' do.
Richardson's do.
Franklin Spermophile, or Great Gopher of Wisconsin and Illinois.
Hare-Squirrel.
Black Squirrel.
Hoary Marmot.
Black-tailed Deer, or Columbia Deer.
Mule-Deer, or Cervus macrotis.
Musk-Ox.
Long-tailed Deer.
Arctic Fox.
Little Otter.
Canada do.
Caribou.
Cinnamon Bear.
Grizzly Bear.
Common Deer.
American Buffalo.
American Elk.
Polar Hare.
Black-tailed Hare.
Virginian Opossum.
Black American Wolf.
Fox-Squirrel.
Prairie-Wolf.
Rocky-Mountain Sheep
Rocky-Mountain Goat.
Moose-Deer.
Prong-horned Atelope.
Ocelot, or Leopard-Cat.
Prairie-Dog, or Marmot-Squirrel.
Swift Fox, or Kit-Fox of plains.
Raccoon.
American Badger.
Specimens of species of Moles, Rats, Mice, Shrews.

# CONTENTS.

ERRATA.

For "about half," read "two fifths," line 23.......... 153
For "two-fifths," read "one-half," line 26.......... 153
For "base," read "case," line 26.......... 160

THE

# CANADIAN

# NATURALIST AND GEOLOGIST.

VOL. VIII. FEBRUARY, 1863. No. 1.

ART. I.—*The Air-Breathers of the Coal Period in Nova Scotia* by J. W. DAWSON, LL.D., F.R.S., &c.

## I. INTRODUCTORY.

The animal population of the earth during the older or palæozoic period of its geological history, is known to us chiefly through the medium of remains preserved in rocks deposited in the bed of the ocean. In such rocks we have little reason to expect an abundant representation of the animals of the land, even if these existed at the time plentifully on the neighbouring shores. Perhaps for this reason,—perhaps because there were then no land animals, the organic remains of the Cambrian, Silurian, and Lower Devonian rocks consist, in so far as animal life is concerned, solely of marine species. In the Upper Silurian and Lower Devonian, however, land plants begin to appear; and in the Upper Devonian these are so numerous and varied as to afford a probability that animals also tenanted the land. Indeed, Mr. Hartt, of St. John, has just announced the discovery of remains, which he believes to be attributable to insects, in the rich plant-bearing Upper Devonian beds of that locality.* It is true also that reptiles of high organization have been found in beds referred to the Upper Devonian, at Elgin, in Scotland; but so much doubt rests on the age of these beds, that it is unsafe at present to regard them as affording evidence of reptilian life at so early a period.

* In a letter to the author. It is to be hoped that descriptions of these interesting remains may soon be published.

That there was dry land, even in the Lower Silurian period, we know, and can even trace its former shores. In Canada our old Laurentian coast extends for more than a thousand miles, from Labrador to Lake Superior, marking the southern border of the nucleus of the American continent in the Lower Silurian period. Along a great part of this ancient coast we have the sand-flats of the Potsdam Sandstone, affording very favorable conditions for the imbedding of land animals, did these exist; still, notwithstanding the zealous explorations of the Geological Survey, and of many amateurs, no trace of an air-breather has been found. I have myself followed the Lower Silurian beds up to their ancient limits in some localities, and collected the shells which the waves had dashed on the beach, and have seen under the Silurian beds, the Laurentian rocks pitted and indented with weather marks, showing that this old shore was then gradually subsiding; yet the record of the rocks was totally silent as to the animals that may have trod the shore, or the trees that may have waved over it. All that can be said is that the sun shone, the rain fell, and the wind blew as it does now, and that the sea abounded in living creatures. The eyes of trilobites, the weathered Laurentian rocks, the wind-ripples in the Potsdam sandstone, the rich fossils of the limestones, testify to these things. The existence of such conditions would lead us to hope that land animals may yet be found in these older formations. On the other hand, the gradual failure of one form of life after another, as we descend in the geological series, and the absence of fishes and land plants in the older Silurian rocks, might induce us to believe that we have here reached the beginning of animal life, and have left far behind us those forms that inhabit the land.

Even in the Carboniferous period, though land plants abound, air-breathers are few, and most of them have only been recently recognized. We know, however, with certainty that the dark and luxuriant forests of the coal period were not destitute of animal life. Reptiles crept under their shade, land-snails and millipedes fed on the rank leaves and decaying vegetable matter, and insects flitted through the air of the sunnier spots. Great interest attaches to these creatures; perhaps the first-born species in some of their respective types, and certainly belonging to one of the oldest land faunas, and presenting prototypes of future forms equally interesting to the geologist and the zoologist.

It has happened to the writer of these pages to have had some share in the discovery of several of these ancient animals. The coal formation of Nova Scotia, so full in its development, so rich in fossil remains, and so well exposed in coast cliffs, has afforded admirable opportunities for such discoveries, which have been so far improved that at least eight out of the not very large number of known Carboniferous land animals, have been obtained from it.* The descriptions of these creatures, found at various times and at various places, are scattered through papers ranging in date from 1844 to 1862,† and are too fragmentary to give complete information respecting the structures of the animals, and their conditions of existence. I have, for some time, designed to prepare a resumé of the published facts, with the addition of such new points as may arise from the further study of the specimens, but have been deterred by the incomplete state of my knowledge, and the prospect of further discoveries. So much has, however, now been done, and so many difficulties have been removed by the labours of several eminent naturalists who have examined the specimens, that I think the time has arrived when such a work may be undertaken with advantage to science.

In now endeavouring more fully to introduce the tenants of the coal forests of Nova Scotia to the notice of geologists and of the general reader, I shall take them nearly in the order in which they have become known to me, and shall not scruple to indulge in some gossip as to the circumstances of their discovery, and in some speculations as to their modes of life. I shall however endeavor carefully to sum up the facts ascertained as to their structure, and their relation to other creatures, whether their contemporaries or successors.

## II. Footprints.

*Plate I.*‡

It has often happened to geologists, as to other explorers of new regions, that footprints on the sand have guided them to the inhabitants of unknown lands. The first trace ever observed of reptiles in the carboniferous system, consisted of a series of small

* It appears that five species of Carboniferous reptiles have been recognised on the continent of Europe, three in Great Britain, and four in the United States. More full references will be made to these in the sequel.

† Papers by Lyell, Owen, and the author, in the Journal of the Geological Society of London, vols. i, ii, ix, x, xi, xvi, xvii, xviii.

‡ This plate will be given in the next number.

but well-marked footprints found by Sir W. E. Logan, in 1841, in the lower coal measures of Horton Bluff, in Nova Scotia; and as the authors of all our general works on geology have hitherto, in so far as I am aware, failed to do justice to this discovery, I shall notice it here in detail. In the year above mentioned, Sir William, then Mr. Logan, examined the coal fields of Pennsylvania and Nova Scotia, with the view of studying their structure, and extending the application of the discoveries as to Stigmaria underclays which he had made in the Welsh coal fields. On his return to England, he read a paper on these subjects before the Geological Society of London, in which he noticed the discovery of reptilian footprints at Horton Bluff. The specimen was exhibited at the meeting of the Society, and was, I believe, admitted on the high authority of Prof. Owen, to be probably reptilian. Unfortunately, Sir William's paper appeared only in abstract in the Transactions; and in this abstract, though the footprints are mentioned, no opinion is expressed as to their nature. Sir William's own opinion is thus stated in a letter to me, dated June, 1843, when he was on his way to Canada to commence the survey which has since developed so astonishing a mass of geological facts.

"Among the specimens which I carried from Horton Bluff, one is of very high interest. It exhibits the footprints of some reptilian animal. Owen has no doubt of the marks being genuine footprints. The rocks of Horton Bluff are below the gypsum of that neighbourhood; so that the specimen in question (if Lyell's views are correct*) comes from the very bottom of the coal series, or at any rate very low down in it, and demonstrates the existence of reptiles at an earlier epoch than has hitherto been determined; none having been previously found below the magnesian limestone, or to give it Murchison's new name, the 'Permian era.'"

This extract is of interest, not merely as an item of evidence in relation to the matter now in hand, but as a mark in the progress of geological investigation. For the reasons above stated, the important discovery thus made in 1841, and published in 1842, was overlooked; and the discovery of reptilian bones by Von Dechen, at Saarbruck, in 1844, and that of footprints by Dr. King in the

* Sir Charles Lyell had then just read a paper announcing his discovery that the gypsiferous system of Nova Scotia is Lower Carboniferous, in which he mentions the footprints referred to, as being reptilian.

same year, in Pennsylvania, have been uniformly referred to as the first observations of this kind. This error I now desire to correct, not merely in the interest of truth, but also in that of my friend Sir William Logan, and of my native province of Nova Scotia; and I trust that henceforth the received statement will be that the first indications of the existence of reptiles in the coal period, were obtained by Logan, in the lower coal formation of Nova Scotia, in 1841. Insects and arachnidans, it may be observed, had previously been discovered in the coal formation in Europe.

The original specimen of these footprints is still in the collection of Sir William Logan. It is a slab of dark colored sandstone, glazed with fine clay on the surface; and having a series of seven footprints in two rows, distant about 3 inches; the distance of the impression in each row being 3 or 4 inches, and the individual impressions about 1 inch in length. They seem to have been made by the points of the toes, which must have been armed with strong and apparently blunt claws, and appear as if either the surface had been somewhat firm, or as if the body of the animal had been partly water-borne. In one place only is there a distinct mark of the whole foot, as if the animal had exerted an unusual pressure in turning or stopping suddenly. One pair of feet, the fore feet I presume, appear to have had four claws; the other pair may have had three or four, and it is to be observed that the outer toe, as in the larger footprints discovered by Dr. King, projects in the manner of a thumb, as in the chierotherian tracks of the Trias. No mark of the tail or belly appears. The impressions are such as may have been made by some of the reptiles to be described in the sequel, as, for instance, by *Dendrerpeton Acadianum.*

Attention having been directed to such marks by these observations of Sir William Logan, several other discoveries of the same kind were subsequently made, in various parts of the province, and in different members of the carboniferous system. The first of these, in order of time, was made in 1844, in beds of red sandstone and shale near Tatamagouche, in the eastern part of Nova Scotia, and belonging to the upper or newer members of the coal measures. In examining these beds with the view of determining their precise geological age, I found on the surface of some of them impressions of worm-burrows, rain drops, and suncracks, and with these, two kinds of footprints, probably of reptilian animals. One kind consisted of marks, or rather scratches, as of three toes, and resembling somewhat the scratches made by the claws of a tortoise in creeping up a bank of stiff clay; they were probably of the same nature and origin with those found by Logan at Horton. The others were of very different appearance. They consisted of two series of strongly marked elongated impressions, without distinct marks of toes, in series four inches distant from each other, and with an intervening tail mark. They seem to have been produced by an animal wading in soft mud, so that deep holes, rather than regular impressions, marked its footsteps, and that in the hind foot, the heel touched the surface, giving a plantigrade appearance to the tracks. Rain marks had been impressed on the surface after the animal had passed over it, and these had probably aided in obliterating the finer parts of the impressions. These observations were published in the Journal of the Geological Society of London, vols. 1st and 2nd.

Shortly afterward, Dr. Harding, of Windsor, when examining a cargo of sandstone which had been landed at that place from Parrsboro', found on one of the slabs a very distinct series of footprints nearly of the size of those previously observed. Dr. Harding's specimen is now in the museum of King's College, Windsor. Its impressions are distinct, and not very different in size and form from those above described as found at Horton Bluff. The rocks at that place are probably of nearly the same age with those of Parrsboro'. I afterward examined the place from which this slab had been quarried, and satisfied myself that the beds are Carboniferous, and probably Lower Carboniferous. They were ripple-marked and sun-cracked, and I thought I could detect trifid footprints, though more obscure than those in Dr. Harding's slab. Similar footprints are also stated to have been found by Dr. Gesner, at Parrsboro'.

I have since observed several instances of such impressions at the Joggins, at Horton, and near Windsor, showing that they are by no means rare, and that reptilian animals existed in no inconsiderable numbers throughout the coal-field of Nova Scotia, and from the begining to the end of the carboniferous period. Two of the more interesting examples are figured with those already described. On comparing these with one another, it will be observed that Logan's, Harding's, and one of mine are of similar dimensions and character, and may have been made by one kind of animal, possibly *Dendrerpeton*, which must have crept on short limbs over the sand. The other belongs to a smaller animal, which probably travelled on longer limbs, more in the manner of an ordinary quadruped. It may have been some species of *Hylonomus*. On the whole, these footprints differ from those found by Dr. King in Pennsylvania; but they do not prove the existence of any kind of animal distinct from those to be described in the sequel, and known to us by the preservation of portions of their skeletons.

The study of these impressions shows that the animals which produced them may, in certain circumstances, have left impressions of only two or three of their toes, while in other circumstances all may have left marks; and that, when wading in deep mud, their footprints were altogether different from those made on hard sand or clay. In some instances the impressions may have been made by animals wading or swimming in water, while in others the rain-marks and sun-cracks afford evidence that the surface was a sub-aerial one. They are chiefly interesting as indicating the wide diffusion and abundance of the creatures producing them, and that they haunted tidal flats and muddy shores, perhaps emerging from the water that they might bask in the sun, or possibly searching for food among the rejectamenta of the sea, or of lagunes and estuaries.

### III. Baphetes planiceps.

*Plate II.*

In the summer of 1851, I had occasion to spend a day at the Albion mines; and on arriving at the railway station in the afternoon, found myself somewhat too early for the train. By way of improving the time thus left on my hands, I betook myself to the examination of a large pile of rubbish, consisting of shale and ironstone from one of the pits, and in which I had previously found scales and teeth of fishes. In the blocks of hard carbonaceous shale and earthy coal, of which the pile chiefly consisted, scales, teeth and coprolites often appeared on the weathered ends and surfaces as whitish spots. In looking for these, I observed one of much greater size than usual, on the edge of a block, and on splitting it open, found a large flattened skull, the cranial bones of which remained entire on one side of the mass, while the palate and teeth, in a more or less fragmentary state, came away with the other half. Carefully trimming the larger specimen, and gathering all the smaller fragments, I packed them up as safely as possible, and returned from my little excursion much richer than I had hoped.

The specimen, on further examination, proved somewhat puzzling. I supposed it to be, most probably, the head of a large ganoid fish; but it seemed different from any thing of this kind with which I could compare it; and at a distance from comparative anatomists, and without sufficient means of determination, I dared not refer it to anything higher in the animal scale. Hoping for further light, I packed it up with some other specimens, and sent it to the Secretary of the Geological Society of London, with an explanatory note as to its geological position, and requesting that it might be submitted to some competent osteologist for examination. For a year or two however, it remained as quietly in the Society's collection as if in its original bed in the coal mine, until attention having been attracted to such remains by the discoveries made by Sir Charles Lyell and myself in 1852, at the South Joggins, and published in 1853,* the Secretary or President of the Society re-discovered the specimen, and handed it to Prof. Owen, by whom it was described in Dec., 1853,† under the name of *Baphetes planiceps*, which may be interpreted the "flat-headed-diving animal," in allusion to the flatness of the creature's skull, and the possibility that it may have been in the habit of diving.

The parts preserved in my specimen are the bones of the anterior and upper part of the skull in one fragment, and the teeth and palatal bones in others. With respect to the former, Prof. Owen recognizes in it the premaxillary (p.) (Fig. 1) and maxillary bones, (m.) both presenting traces of the sockets of teeth, which appear to be in a single series; but other fragments show that in part at least, they were in double series. The central portion of the skull and part of the orbits are made up of the nasals, (n.) the frontal (fr.) and the prefrontal (pf.) in a manner characteristic of the Labyrinthodont reptiles, and not of fishes. The upper surface of the bone, seen in some detached fragments, as in Fig. 4, has a pitted surface, like that of the stone of a peach, as is the case also in the Labyrinthodonts. In sections under the microscope, the bone shows vascular canals and small rounded bone-cells, a structure observed, in *Labyrinthodon*, and in some of the larger Saurians (Figs. 2 and 8). The teeth are conical, and somewhat curved, the outer series from a line to two lines in diameter, and the inner series three lines or more (Figs. 3 and 5). They are

* Journal of Geological Society of London, vol. ix.

† Journal of Geological Society, vol. x; and additional notes, vol. xi.

implanted in shallow sockets in the maxillary and premaxillary bones, and are anchylosed to the sockets. For the lower third, the outer surface presents shallow vertical grooves, conformably with the plicated character of the internal structure (Figs. 3, 7, and 10). The upper portion is smooth, and its internal structure presents merely radiating tubes of ivory, and concentric layers. (Figs. 3, 6, and 9). The whole of these characters are regarded as allying the animal with the great crocodilian frogs of the Trias of Europe, first known as *Cheirotherians*, owing to the remarkable hand-like impressions of their feet, and afterwards as *Labyrinthodonts*, from the beautifully complicated convolutions of the ivory of their teeth.

The only additional remains attributable to this creature, found since the publication of Professor Owen's description, are the bone represented in Fig. 12, and the scute or scale represented in Fig. 11. The former may be a scapular or sternal bone, and, if so, would warrant the belief that the creature possessed anterior limbs of considerable size; the proportion relatively to the skull being much the same as in the American bullfrog. The latter is marked in the same way as the bones of the head, and would indicate that *Baphetes* was protected by bony dermal scales, resembling those of the crocodile.

There is one point illustrated by the bone represented in Fig. 12, to which I would earnestly invite the attention of comparative anatomists. It is the distortion to which bones are subjected when imbedded in soft deposits, especially those containing vegetable matter. In modern peat bogs, skulls have been found nearly as pliable as leather, owing to the partial removal of their phosphate of lime; and in clay beds they are often found softer than chalk, from to the removal of their animal matter. Human skulls, buried under no great weight of earth, have often been strangely distorted from this posthumous softening. Even teeth are affected in this way. In the remains of the old Indian village of Hochelaga, at Montreal, while the teeth of bears are found in the drier and more sandy soil quite perfect and unaltered, in damp places, and where they are imbedded in organic matter thrown out from the cabins, they are softened, so that a large canine may be easily compressed between the finger and thumb. Changes of this kind have no doubt been experienced by all the bones imbedded in coal, carbonaceous shale, and similar deposits; and in the great compression which the mass has experienced, the bones, yielding with it, have been flattened and distorted in the most remarkable manner. In the bones, in short, as in the plants of the coal, the flattened specimen must not be accepted as representing the original form. The bone represented in Fig. 12, for example, must have been strong, and nearly cylindrical in its middle portion, and much curved, but it has given way to pressure, and has as it were been *faulted* along certain lines, so as to lose almost entirely its original relief. The sectional view in Fig. 13, represents some of these faults, with the present profile of the bone, its original outline being represented by the dotted line. The title of the present species to the specific name *planiceps*, is also in part dependent on this cause. No doubt its head, like that of other batrachians, was somewhat flat, but this has been much increased by pressure; in so much that the fragments of the specimen show that the palate is almost brought into contact with the roof of the skull, and that scarcely a quarter of an inch is left in some places for the depth of the great orbits. The interior of the skull must have been filled with soft slime, and this has been compressed into a hard stone. In like manner, I shall have occasion to show, in reference to other reptiles of the coal, that their bones have been much altered in form, so that limb bones, which, when buried in a nearly erect position, show broad and flat articulating surfaces, have these compressed into mere edges, when the specimens lie horizontally, and that hollow bones have been fractured longitudinally, and pressed almost perfectly flat. Anatomists may be very easily misled by such appearances, and should carefully enquire as to the possibility of their occurrence, before deducing inferences from the forms of bones.

Of the general form and dimensions of *Baphetes*, the facts at present known, do not enable us to say much. Its formidable teeth and strong maxillary bones show that it must have devoured animals of considerable size, probably the fishes whose remains are found with it, or the smaller reptiles of the coal. It must in short have been crocodilian, rather than frog-like, in its mode of life; but whether, like the labyrinthodonts, it had strong limbs and a short body, or like the crocodiles, an elongated form and a powerful natatory tail, the remains do not decide. One of the limbs, or a vertebra of the tail would settle this question, but neither have as yet been found. That there were large animals of the labyrinthodontal form in the coal period, is proved by the footprints discovered by Dr. King in Pennsylvania, which may have been produced by an animal of the type of *Baphetes*. On the other hand that there were large swimming reptiles, seems established by the recent discovery of the vertebræ of *Eosaurus Acadianus*, at the Joggins, by Mr. Marsh.* The locomotion of *Baphetes* must have been vigorous and rapid, but it may have been effected both on land and in water, and either by feet or tail, or both.

With the nature of its habitat we are better acquainted. The area of the Albion Mines coal field was somewhat exceptional in its character. It seems to have been a bay or indentation in the Silurian land, separated from the remainder of the coal-field by a high shingle beach, now a bed of conglomerate. Owing to this circumstance, while in the other portions of the Nova Scotia coal field, the beds of coal are thin, and alternate with sandstones and shales, at the Albion Mines a vast thickness of almost unmixed vegetable matter has been deposited, constituting the 'main seam' of thirty-eight feet thick,and the 'deep seam' twenty-four feet thick, as well as still thicker beds of highly carbonaceous shale. But, though the area of the Albion coal measures was thus separated, and preserved from marine incursions, it must have been often submerged, and probably had connection with the sea, through rivers or channels cutting the enclosing beach. Hence beds of earthy matter occur in it, containing remains of large fishes. One of the most important of these is that known as the "Holing stone," a band of black highly carbonaceous shale, coaly matter, and clay ironstone, occurring in the main seam, about five feet below its roof, and varying in thickness from two inches to nearly two feet. It was from this band, that the rubbish-heap, in which I found the skull of *Baphetes planiceps*, was derived. It is a laminated bed, sometimes hard and containing much ironstone, in other places soft and shaly : but always black and carbonaceous, and often with layers of coarse coal, though with few fossil plants retaining their forms. It contains large round flat scales and flattened curved teeth, which I attribute to a fish of the genus *Rhizodus*, resembling, if not identical with, *R. lancifer*, Newberry. With these are double pointed shark-like teeth, and long cylindrical spines of a species of *Diplodus*, which I have named *D. acinaces*.† There are also shells of the minute *Spirorbis*, so common in the coal measures of other parts of Nova Scotia, and abundance of frag-

* Silliman's Journal, 1859.

† Supplement to Acadian Geology, pp. 43 and 50.

ments of coprolitic matter. I have also observed in it a few scales having the peculiar one-sided form of those of *Archegosaurus* and *Dendrerpeton;* and which I may possibly describe and figure, among miscellaneous indications of unknown creatures, in the end of this memoir.

It is evident that the "Holing stone" indicates one of those periods in which the Albion coal area, or a large part of it, was under water, probably fresh or brackish, as there are no properly marine shells in this, or any of the other beds of this coal series. We may then imagine a large lake or lagune, loaded with trunks of trees and decaying vegetable matter, having in its shallow parts, and along its sides, dense brakes of *Calamites*, and forests of *Sigillaria*, *Lepidodendron*, and other trees of the period, extending far on every side as damp pestilential swamps. In such a habitat, uninviting to us, but no doubt suited to *Baphetes*, that creature crawled through swamps and thickets, wallowed in flats of black mud, or swam and dived in search of its finny prey. It was, in so far as we know, the monarch of these swamps, though there is evidence of the existence of similar creatures of this type quite as large in other parts of the Nova Scotia coal field; but my notice of these I defer for the present, in hope that additional facts may be discovered in respect to them. If this should not be the case they will be noticed among miscellaneous remains in the sequel.

---

## EXPLANATION OF PLATE II.

*Baphetes planiceps.*

Fig. 1.—Skull seen from below, half natural size.

" 2.—Portion of bone of skull magnified, to show vascular canals and bone-cells.

" 3.—One of the largest teeth, natural size.

" 4.—Sculpturing of skull, and margin of orbit, natural size.

" 5.—Fragment of maxillary bone, with four teeth of the outer series, and one of the inner large teeth,—the points of the teeth restored from fragments in other specimens.

" 6 and 7.—Sections of a tooth magnified: 6, upper part; 7, lower part, with convoluted dentine.

" 8.—Section of bone in Fig. 2, more highly magnified.

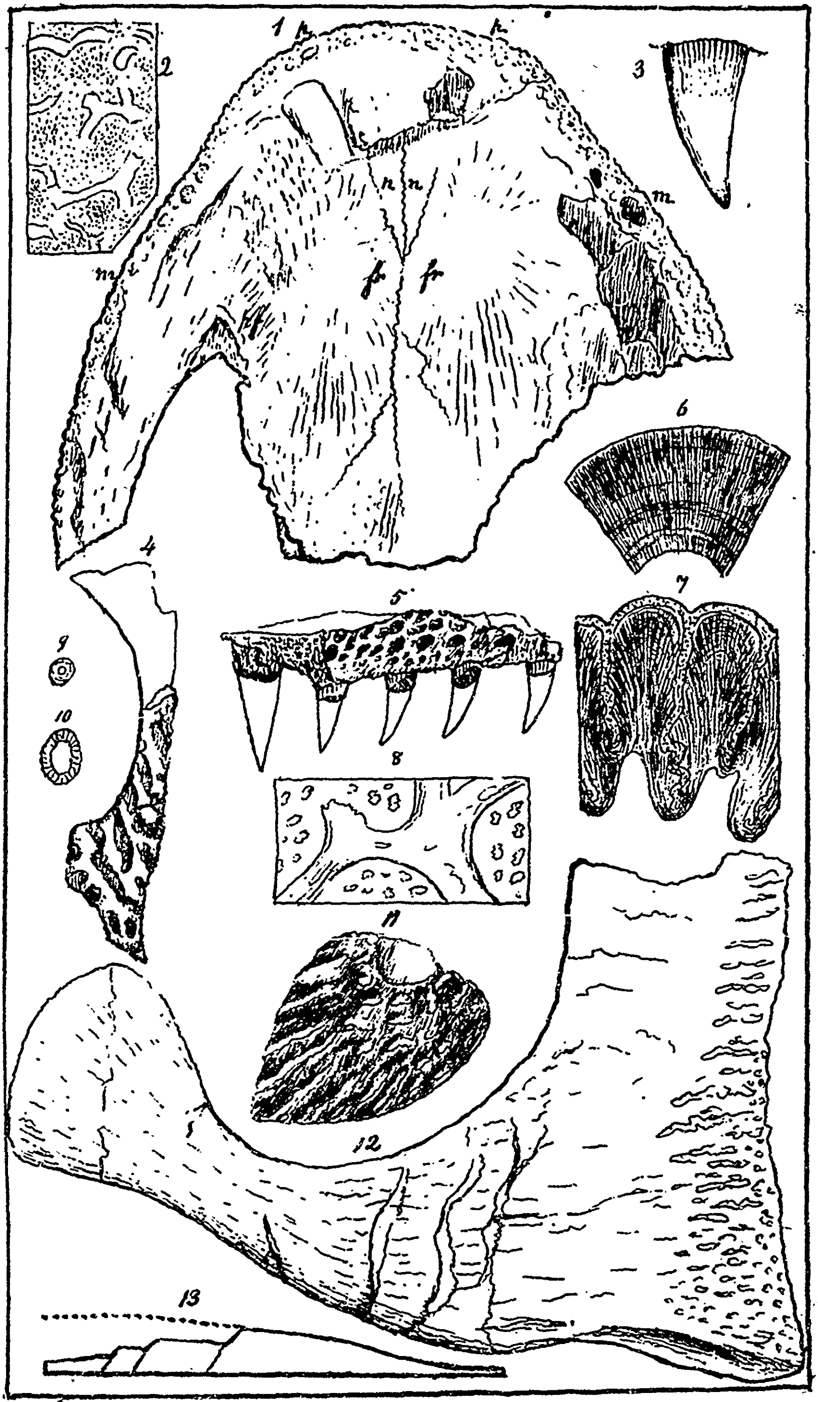
" 9 and 10.—Sections of tooth represented in Figs. 6 and 7, natural size.

" 11.—Dermal scale found with remains of *Baphetes.*

" 12.—Scapular or sternal bone found with remains of *Baphetes.*

" 13.—Longitudinal section of the middle of the same, showing the manner in which it has been crushed.

(*To be continued.*)




BAPHETES PLANICEPS, *Owen.*

ART. II.—*On the Gold Mines of Canada, and the manner of working them.*

The existence of gold in the sands of the Chaudière valley, to the south of Quebec, was, so far as we are aware, first announced to the world by General Baddeley (then Lieutenant) of the Royal Engineers, in the year 1835, and by him communicated to Prof. Silliman. (see American Journal of Science for that year, vol. xxviii. p. 112.) In 1847, and the three or four years following, careful examinations were made in that region by the Geological Survey, and it was found that the precious metal is not confined to the valley of the Chaudière, but exists in the superficial deposits of a wide area.

The source of the gold throughout this extent appears to have been the breaking up of the crystalline schists of the region, in which the metal has occasionally been met with. One example of this is in a vein of quartz in clay state, in the parish of St. Francis, on the Chaudière, where it occurs with argentiferous galena, arsenical pyrites, cubic iron pyrites and sulphuret of zinc,—the latter two ores containing a notable proportion of gold. The results of assays of all these materials will be found in the reports of the Geological Survey for 1853, page 370. During the past year, another vein of quartz, about one hundred yards from this last has yielded very rich and beautiful specimens of native gold, also accompanied by arsenical pyrites. The precious metal occurs again not far from the Harvey Hill copper mine, in Leeds, at a locality known as Nutbrown's shaft, which is sunk on a vein of bitter-spar, holding specular iron, vitreous copper ore, and native gold, generally in small grains or scales. Some specimens from this locality, however, have weighed as much as a pennyweight. The only attempts as yet made at gold-mining in Canada have been in the diluvial deposits. We extract from the General Report of the Geological Survey of Canada, now in press, and soon to appear, the following details with regard to these deposits, together with the results of some of the trials hitherto made to work them, and suggestions as to the best mode of obtaining the gold.

"These rocks of eastern Canada may be traced south-westwardly through New England, along the Appalachian chain, to the state of Georgia; and furnish gold in greater or less quantity in nearly every part of their extension. They constitute the great gold-bearing formation of eastern North America, which in its mineralogical and lithological characters is similar to that of the western coast, and to those of Russia aud Australia. These auriferous rocks in Canada; belong for the greater part to the Quebec group, of Lower Silurian age; but the quartz veins containing gold, mentioned above, are found cutting strata, which are supposed to belong to the Upper Silurian period. The auriferous drift covers a wide area on the south s ide of the St. Lawrence, including the hill country belonging to the Notre Dame range, and extending thence south and east to the boundary of the province. These wide limits are assigned, inasmuch as although gold has not been everywhere found in this region, the same mineralogical characters are met with throughout. In its continuation southward in Plymouth, and elsewhere in Vermont, considerable quantities of gold have been obtained from the diluvial deposits. In Canada, gold has been found on the St. Francis River, from the vicinity of Melbourne to Sherbrooke; in the townships of Westbury, Weedon, and Dudswell, and on Lake St. Francis. It has also been found on the Etchemin, and on the Chaudière, and nearly all its tributaries, from the seigniory of St. Mary to the frontier of the state of Maine; including the Bras, the Guillaume, the Rivière des Plantes, the Famine, the Du Loup, and the Metgermet. Several attempts have been made to work these alluvial deposits for gold, in the seigniories of Vaudreuil, Aubert-Gallion, and Aubert de l'Isle, but they have been successively abandoned; and it is difficult to obtain authentic accounts of the result of the various workings, although it is known that very considerable quantities of gold were extracted. The country people still, from time to time, attempt the washing of the gravel, generally with the aid of a pan, and are occasionally rewarded by the discovery of a nugget of considerable value. In the years 1851 and 1852, an experiment of this kind, on a considerable scale, was tried by the Canada Gold Mining Company, in the last named seigniory, on the Rivière du Loup, near its junction with the Chaudière. The system adopted for the separation of the gold from the gravel was similar to that used in Cornwall in washing for alluvial tin, and the water for the purpose was obtained from a small stream adjoining. Great difficulties were however met with, from a deficient supply of water during the summer months. The gravel from about three-eighths of an acre, with an average thickness of two feet, was washed during the summer of 1851, and yielded 2,107 pennyweights of gold; of which 160 were in the form of fine dust, mingled with about a ton of black iron sand, the heavy residue of the washings. There were several pieces of gold weighing over an ounce. The value of this gold was $1,826, and the whole expenditure connected with the working $1,643, leaving a profit of $182. In this account is, however, included $500 lost by a flood, which swept away an unfinished dam; so that the real difference between the amount of the wages and the value of the gold obtained should be stated at $682. The average price of the labor employed was sixty cents a day."

"In 1852, about five-eighths of an acre of gravel were washed at this place, and the total amount of gold obtained was 2,880 pennyweights, valued at $2,496. Of this, 307 pennyweights were in the form of fine dust mixed with the iron sand. A portion was also found in nuggets or rounded masses of considerable size. Nine of these weighed together 468 pennyweights, the largest being about 127, and the smallest about 11 pennyweights. Small portions of native platinum, and of iridosmine, were obtained in these washings, but their quantity was too small to be of any importance. The washing season lasted from the twenty-fourth of May to the thirtieth of October, and the sum expended for labor was $1,888, leaving a profit of $608. A part of this expenditure was, however, for the construction of wooden conductors for bringing the water a distance of about 900 feet from the small stream. As this work would be available for several years to come, a proper allowance made for it would leave a profit in the year's labor of about $680. It thus appears that from an acre of the gravel, with an average thickness of two feet, there were taken $4,323 of gold; while the expenses of labor, after deducting, as above, all which was not directly employed in extracting gold, were $2,957, leaving a profit of $1,366. The fineness of the gold dust of this region was 871 thousandths; another sample in thin scales gave 892, and masses 864. A small nugget of gold from St. Francis gave 867 thousandths, the remainder in all cases being silver."

"Although the greater part of this gold was extracted from the gravel on the flats by the river side, a portion was obtained by washing the material taken from the banks above. As has been before remarked, the distribution of the gold-bearing gravel over the surface of the country took place before the formation of the present water courses, and the reason why the gravel from the beds of these are richer in gold than that which forms their banks, is that these rapid streams have subjected the earth to a partial washing, carrying away the lighter materials, and leaving the gold behind with the heavier matters. According to Mr. Blake, it is found in California, that the gold in the diluvial deposits, which have not been subsequently disturbed by the streams, is not uniformly distributed, but is accumulated here and there in quantities greater than in other places. It would seem that during the first deposition of the earth and gravel, the precious metal became in some parts accumulated in depressions of the surface rock, constituting what are called pockets by the miners. It would appear from the facts here given that the quantity of gold in the valley of the Chaudière is such as would be remunerative to skilled labour, and should encourage the outlay of capital. There is no reason for supposing that the proportion of the precious metal to be found along the St. Francis, the Etchemin, and their various tributaries, is less considerable than that of the Chaudière."

"What is called the hydraulic method of washing deposits of auriferous gravel is adopted on a great scale in California, and to some extent in the states of Georgia and North Carolina. In this method, the force of a jet of water, with great pressure, is made available, both for excavating and washing the auriferous earth. The water, issuing in a continuous stream, with great force, from a large hose-pipe, like that of a fire-engine, is directed against the base of a bank of earth and gravel, and tears it away. The bank is rapidly undermined, the gravel is loosened, violently rolled together, and cleansed from any adhering particles of gold; while the fine sand and clay are carried off by the water. In this manner hundreds of tons of earth and gravel may be removed, and all the gold which they contain liberated and secured, with greater ease and expedition than ten tons could be excavated and washed in the old way. All the earth and gravel of a deposit is moved, washed, and carried off through long sluices, by the water, leaving the gold behind. Square acres of earth on the hill sides may thus be swept away into the hollows, without the aid of a pick or a shovel in excavation. Water performs all the labor, moving and washing the earth, in one operation; while in excavating by hand, the two processes are of necessity entirely distinct. The value of this method, and the yield of gold by it, as compared with the older one, can hardly be estimated. The water acts constantly, with uniform effect, and can be brought to bear upon almost any point, where it would be difficult for men to work. It is especially effective in a region covered by trees, where the tangled roots would greatly retard the labor of workmen. In such places, the stream of water washes out the earth from below, and tree after tree falls before the current, any gold which may have adhered to the roots being washed away. With a pressure of sixty feet, and a pipe of from one and a half to two inches aperture, over a thousand bushels of earth can be washed out from a bank in a day. Earth which contains only one twenty-fifth part of a grain of gold, equal to one-fifth of a cent in value to the bushel, may be profitably washed by this method; and any earth or gravel which will pay the expense of washing in the old way, gives enormous profits by the new process. To wash successfully in this way requires a plentiful supply of water, at an elevation of from fifty to ninety feet above the bed-rock, and a rapid slope or descent from the base of the bank of earth to be washed, so that the waste water will run off through the sluices, bearing with it gravel, sand, and the suspended clay."

"The above description, and the added details are copied from a report on the gold mines of Georgia, by Mr. William P. Blake, who has carefully studied this method of mining in California, and by whose recommendation it has been introduced into the southern states. He states that in the case of a deposit in North Carolina, where ten men where required, for thirty-five days, to dig the earth with pick and shovel, and wash it in sluices, two men, with a single jet of water, would accomplish the same work in a week. The great economy of this method is manifest from the fact that many old deposits in the river beds, the gravel of which had been already washed by hand, have been again washed with profit by the hydraulic process. He tells us that in California the whole art of working the diluvial gold deposits was revolutionized by this new method. The auriferous earth, lying on hills, and at some distance above the level of the water-courses, would, in the ordinary methods, be excavated by hand, and brought to the water; but by the present system, the water is brought by aqueducts to the gold deposits, and whole square miles, which were before inaccessible, have yielded up their precious metal. It sometimes happens, from the irregular distribution of the gold in the diluvium in California, that the upper portions of a deposit do not contain gold enough to be washed by the ordinary methods; and would thus have to be removed, at a considerable expense, in order to reach the richer portions below. By the hydraulic method, however, the cost of cutting away and excavating is so trifling, that there is scarcely any bank of earth which will not pay the expense of washing down, in order to reach the richer deposits of gold beneath.

"The acqueducts or canals for the mining districts of California are seldom constructed by the gold workers themselves, but by capitalists, who rent the water to the miners. The cost of one of these canals, carrying the waters of a branch of the Yuba River to Nevada County, was estimated at a million of dollars; and another one, thirty miles in length, running to the same district, cost $500,000. The assessed value of these various canals in 1857 was stated to be over four millions of dollars, of which value one-half was in the single county of Eldorado. The Bear River and Auburn Canal is sixty miles in length, three feet deep and four feet wide at the top, and cost in all $1,600,000; not withstanding which, the water-rents were so great that it is stated to have paid a yearly dividend of twenty per cent, while other similar canals paid from three, to five and six per cent., and even more, monthly. The price of the water was fixed at so much the inch, for each day of eight or ten hours. This price was at first about three dollars, but by competition has now been greatly reduced.

"From these statements, it will be seen that the great riches which have of late years been drawn from the gold mines of California, have not been obtained without the expenditure of large amounts of money and engineering skill. This last is especially exhibited in the construction of these great canals, and the application of the hydraulic method to the washing of auriferous deposits, which were unavailable by the ordinary modes of working, on account of their distance from the water-courses, or by reason of the small quantity of gold which they contain.

"In order to judge of the applicability of this method of washing to our own auriferous deposits, a simple calculation based upon the experiments at the Rivière du Loup will be of use. It has been shown that the washing of the ground over an area of one acre, and with an average depth of two feet, equal to 87,120 cubic feet, gave, in round numbers, about 5000 pennyweights of gold, or one and thirty-eight hundredths grains to the cubic foot; which is equal to one and three-quarters grains of gold to the bushel. Now, according to Mr. Blake, earth containing one forty fourth part of this amount, or one twenty-fifth of a grain of gold, can be profitably washed by the hydraulic method, while the labor of two men, with a proper jet of water, suffices to wash one thousand bushels in a day, which in a deposit like that of Rivière du Loup would contain about seventy-three pennyweights of gold. It is probable however that a certain portion of the finer gold dust, which is collected in the ordinary process, would be lost in working on the larger scale. It has already been shown that the gold is not confined to the gravel of the river channels, and the alluvial flats. The beds of interstratified clay, sand, and gravel, which occur on the banks of the Metgermet, were found to contain gold throughout their whole thickness of fifty feet, and even though its proportion were to be many times less than in the gravel of the Rivière du Loup, these thick deposits, which extend over great areas, might be profitably worked by the hydraulic method. The fall in most of the tributaries of the Chaudière and of the St. Francis throughout the auriferous region, is such that it will not be difficult to secure a supply of water with a sufficient head, without a very great expenditure in the construction of canals; and it may reasonably be expected that before long the deposits of gold-bearing earth, which are so widely spread over southeastern Canada, will be made economically available."

T. S. H.

---

ART. III.—*On the Parallelism of the Quebec Group with the Llandeilo of England and Australia, and with the Chazy and Calciferous formations*; by E. BILLINGS, F.G.S.

*(Read before the Nat. Hist. Society of Montreal, 3rd Feb. 1863.)*

In the following paper, it is proposed to review some of the more prominent facts and opinions relating to the age of the Quebec group, as compared with certain other formations in Europe, Australia, and America, whose true position is well established. During the last four years, great progress has been made towards the solution of this problem, and a general conclusion has been arrived at, which I believe will stand the test of time. But the subject is far from being exhausted. There yet remain numerous secondary and collateral questions of more or less difficulty, which can be only decided by much further investigation in the field. In the meantime, the tract of country wherein these rocks are most extensively developed, has become of great importance, on account of its stores of mineral wealth; and everything therefore relating to its geological structure, is of interest, not only in a scientific, but also in an economical point of view.

In 1860, Sir W. E. Logan, after having re-examined the whole subject, came to the conclusion that the position, to which these rocks had been previously referred, was too high up in the series, and that they lie near the base, rather than in the upper half of the Lower Silurian. This opinion was published in the Canadian Naturalist and Geologist of December, in the same year.* Since that time a vast deal of new evidence has been collected, all tending to prove that this view is the correct one. Endeavours are being made, however, by means of pamphlets, published by Mr. Marcou, of Boston, and circulated in Canada, the United States, and Europe, to show that the Quebec group does not belong to the Lower Silurian at all, and that it lies below the Potsdam sandstone, in the primordial zone. But unfortunately for this theory, the papers containing the physical and palæontological evidence, published by the Canadian Survey, are in the hands of all the great European geologists, and have furnished them with the means of forming their own opinions upon the subject. The views of these men, are to us of the highest value, coming as they do from those who by their world-wide experience and oft tested ability, are acknowledged on all hands, to be the highest authorities on all that relates to the lower palæozoic formations.

Sir R. I. Murchison, in his address to the Geological Section of the British Association, in 1861, publicly announced his entire concurrence with us in the important change that had been made.

M. J. Barrande has, in several papers published in the Bulletin of the Geological Society of France, and in Bronn's Neues-

* The fossils upon which the age of the Quebec group was determined were collected in May and June, 1860. On the 12th of July I wrote to Barrande, informing him of the discovery, and that they (the fossils) proved that the Point Levis rocks belonged to a horizon near the base of the second fauna. In August, I published the descriptions of the trilobites in the Canadian Naturalist and Geologist, and on that occasion the use of the designation "Hudson River Group," as the name of the formation was first discontinued. Barrande communicated (in a letter dated Paris, 14th August, 1860,) the substance of my letter to Mr. Marcou, and it was by him published in the proceedings of the Boston Natural History Society in November following.

Jahrbuch, pronounced the greater number of the fossils, described and figured by us from the Quebec group, to be Lower Silurian, while in his opinion the others present a primordial aspect.

PROF. F. McCOY, Director of the National Museum of Victoria, in Australia, in a paper published in the Annals of Natural History in February, 1862, announced the discovery of the compound graptolites of the Quebec group "in the slates of North Melbourne containing the auriferous quartz-veins of the gold-fields."* He identified the Australian slates with the Llandeilo rocks of Wales, Scotland and Ireland on the one hand, and with the Quebec group on the other. The compound graptolites were first discovered and brought into notice by the Canadian Survey; and it is to us a source of great satisfaction, that they have now become, in the hands of skilful palæontologists the means, by which rocks, separated from each other by a distance nearly equal to half the circumference of the globe, can be proved to be of the same geological age. The gold fields of the Chaudière, near Quebec, appear thus to lie in the same horizon with those of Australia. It would also seem, that the compound, differ from the simple graptolites, in being more persistently confined to a particular period near the base of the Lower Silurian.

PROF. R. HARKNESS and J. W. SALTER, on the 17th of December last, read a paper before the Geological Society, which bears so importantly upon our discoveries in the Quebec group that I shall quote the abstract of it entire as published in the Geologist of January, 1863. It is as follows:—

*December 17th.*—"On the Skiddaw Slate Series." By Prof. R. Harkness; with a note on the Graptolites, by Mr. J. W. Salter. Some general sections through the Skiddaw Slates were described in detail, and the localities in which fossils had been previously found by Professor Sedgwick were especially noticed. The author stated that he had discovered several species of Graptolites, new to the Skiddaw Slates, in certain flaggy beds almost devoid of cleavage, which occur at intervals in the lower portion of the series, in several localities. Professor Harkness showed that these rocks were much more fossiliferous than had hitherto been supposed; and that the evidence of the fossils, as interpreted by Mr. Salter, clearly proved them to be of the same age as the Lower Llandeilo rocks of Wales, and the Quebec group of Canada. The thickness of the Skiddaw Slates was estimated at 7000 feet, and the total thickness from the base of the Skiddaw Slates to the Coniston limestone

* It does not seem to be clearly proved that the gold actually belongs to the graptolitic slates.

at 13,000 feet. Besides several species of well-known Graptolites that are also found in the Lower Llandeilo rocks and in the Quebec group (Taconic System),* Mr. Salter has been enabled to identify *Phyllograpsus angustifolium*, Hall, *Tetragrapsus bryonoides*, Hall, and another species of that genus, *Dichograpsus Sedgwicki*, n. sp., *Didymograpsus caduceus*, and some others. He has given the name of *Caryocaris Wrightii* to a Crustacean discovered in these rocks by Mr. Wright. Mr. Salter considers the Skiddaw Slates to be of the same age as the Quebec Group, the graptolitiferous rocks of Melbourne, and the Tremadoc Slates of Wales.

All the above proves, clearly enough, that in the opinion of the best European geologists, the age of the Quebec group has been correctly determined by the Canadian Survey. In Sir W. E. Logan's first paper it is stated that "*it appears to be a great development of strata about the age of the Chazy and Calciferous*," and it is well known that for several years past these two formations have been classified in the Provincial Geological Museum as representing the Llandeilo. The cards placed in the cases to indicate this parallelism, refer the Calciferous to the Lower, and the Chazy to the Upper Llandeilo. This must be understood in a general sense, because, as in England it is impossible to point out the identical line of demarcation between the Llandeilo and the Lingula flags below, or between the Llandeilo and the Bala group above, so it is (with more reason) not possible to parallel, bed for bed, the American with the European sub-divisions of these ancient formations. The great point decided by the Canadian Survey in 1860 is this,—that the Quebec group is not the upper part of the Lower Silurian to which it had always been referred by some geologists; neither does it lie in the primordial zone, as was then and is still maintained by others, but it occupies a position between these two levels.

The fossils of the Quebec group, are mostly all new species, those which are not new being specifically identical with those which occur in the Chazy and Calciferous, in the typical localities of the north-western division of the Silurian of Canada and New York, where the strata are undisturbed. But not one species has been found which occurs in the Hudson River formation. There are some species of *Orthoceras Murchisonia* and *Pleurotomaria* that might be at first sight taken for well known Trenton or Black

* The Quebec group is only in part Taconic, as it includes rocks which Emmons expressly excluded. I do not think he will claim any of the Quebec group when he becomes satisfied that it all lies above the Potsdam.—E. B.

River forms; but fortunately several of them are silicified; and when perfect specimens are worked out of the limestone-matrix, by the application of acid, they are found to differ, not a great deal, it is true, but, to such an extent that many naturalists would pronounce them to be distinct from those of the two formations mentioned. All the genera of trilobites that have been found in the Trenton, except *Acidaspis*, *Bronteus*, *Calymene*, and *Encrinurus*, occur in the Quebec group. On the other hand we find all the Potsdam and Taconic genera, except *Atops*, *Bathynotus*, and *Aglaspis*. Along with these there are several new genera of trilobites and some European types, such as *Ampyx*, *Nileus*, *Holometopus* and *Æglina*, not yet known as occurring in the north-western portion of the palæozoic basin of America.

We have thus in the Quebec group, that intermingling of the types, of the first and second faunæ, that must be expected in a formation whose true position is low down in the Silurian series and near the primordial zone. And as the species properly belonging to the second fauna, are vastly in the majority, we have assigned to the formation a position a little above the Potsdam group.

Such being, in substance, the general conclusion that has been arrived at, *i. e.* that the Quebec group is situated in the lower half of the lower Silurian, it is next to be shewn, to which of the American sub-groups it can be paralleled. And here we must, perhaps, make some allowance for the existence of zoological provinces in the Silurian seas, similar to those of the present day. If a line be drawn following the St. Lawrence from its mouth to the neighbourhood of Quebec, thence to the northern extremity of Lake Champlain and then along the lake to Whitehall; thence to Albany and along the Appalachians to Tennessee, I think it will be found, that the palæozoic rocks lying south-east of that line contain some groups of fossils, to a great extent specifically distinct from those imbedded in rocks of the same age lying north-west of it. In this way we may in part, but not altogether, account for the extraordinary fact of the Quebec group yielding such a large number of species distinct from those occurring in New York and Canada west.

Or, it might be explained, by supposing that in the south-eastern region, there are deposits which do not exist in the north-west. The thickness of the Calciferous and Chazy in Canada west of the line, cannot be much over 600 feet, while the Quebec group is at least 6000. In Pennsylvania, Prof. Rogers says, his Auroral series,—supposed by him (and correctly too I believe) to represent the calciferous Chazy and Black River,—is from 2500 to 5500 feet thick. It is thus very clear that, either the same strata must be greatly thicker in the south-eastern region than they are in the north-western, or else that the whole formation is swollen by additional deposits. Perhaps both of these reasons should be taken into account.

In 1859 I made an examination of all the Calciferous and Chazy fossils, in the Provincial Museum, and found that there were 41 species in the former and 129 in the latter, but not one species was clearly identified as common to the two formations. I believe that between the Calciferous and Chazy, as developed west of the line, in Canada, there is an almost total break in the succession of life. There are few geologists who believe in periodic extinctions of all animal life extending over the whole earth. It is almost, certain, that gaps of this kind are mere local phenomena.

And if so, then somewhere else strata will sooner or later be found, holding a fauna composed partly of species occurring in the beds below and partly of those found in beds above the gap, thus connecting the two formations. I think it probable that a large portion of the Quebec group is of an age between the Calciferous and Chazy. But I do not believe that this would be sufficient to account for so great a number of species distinct from those of these two formations. The existence of zoological provinces in the Silurian seas, although not yet clearly proved, is something that should always be kept in mind, while endeavouring to work out a problem such as that presented by the fauna of the Quebec group.

Of the 129 species of the Chazy limestone, twenty-one pass upwards into the overlying formations. In the Black River limestone, lying just on the top of the Chazy, we find a sudden and great increase in the number of species. Nearly all of these pass upwards into the Trenton and many of them into the Hudson River. There is here another break (between the Chazy and Black River) but not so decided as that between the Calciferous and Chazy. When we find (as in the instance of the Black River and Trenton Fauna) a sudden appearance of a vast number of new species, we must suppose either that all these new species were suddenly created at the time the beds, in which we first find them, were deposited; or, that previous to the deposition of these beds, they lived in some other tract of the ocean. I am inclined to believe in the latter view. In the Quebec group, in Newfoundland, we find in beds lying below those holding *Bathyurus Saffordi* and the compound graptolites, several species which can scarcely be distinguished from well known Black River and Trenton forms. They are all a little different, but still so closely allied that I am greatly at a loss to decide whether or not they should receive new names. This can only be settled by first deciding the question of the difference between varieties and true species. The fossils in question are either identical with, or are varieties of the following species: *Murchisonia gracilis*, *M. bellicincta*, *M. bicincta*, *Orthoceras Allumettense*, and *O. Bigsbyi*,(the latter *Ormoceras tenuifilum* of Hall). The first three of these species are, as is well known, common in the Black River and Trenton ; *O. Allumettense* occurs both in the Chazy and Black River, but has not yet been found in the Trenton, while *O. Bigsbyi* seems to be confined to the Black River. I think these species lived in the south-eastern region during the period of the deposition of the Quebec group, and (either they or their modified descendants) migrated north-westerly during the Chazy and Black River periods.

If we compare the whole fauna of the Quebec group with that of the Black River and Trenton, we shall find that the two cannot be identified at all upon any known principle of zoology. The difference cannot be explained away by the theory of distinct zoological provinces, because there are places (such as at Montmorency) where the Trenton limestone, crowded with its own species can be seen lying in horizontal strata, while just across the channel which separates that locality from the Island of Orleans, (almost within gunshot) the enormous mass of the Quebec group with its compound graptolites and mixed fauna of primordial and silurian trilobites is grandly displayed. It is impossible that two faunæ, totally different could live for ages within a mile of each other in the ocean, without any barrier between them, and retain their distinctive characters.

There is none of the true Chazy and Calciferous in the neighbourhood of Quebec. But at Highgate Springs, near Phillipsburgh, at the northern extremity of lake Champlain, there is an exposure of the Chazy, Black River and Trenton limestones. The two latter formations can be easly identified by their fossils and lithological characters, but the beds supposed to represent the Chazy consist of sandstone shales and nodular limestones, and differ somewhat from the formations elsewhere, and besides are almost destitute of fossils. They certainly underlie the Black River. The only species identified in these beds are *Ptilodictya fenestrata*, *Orthis platys* and *Ampyx Halli*. The first two of these are good Chazy species, in the typical localities, but the last is not; and I may mention here that no species of *Ampyx* has yet been found in the north-western region of our palæozoic basin, but I know of four or five in the south-eastern; all, either in the Chazy, or in the Quebec group, except one at Gaspé, which occurs in slates the age of which is not determined. One of the species occurs in Tennessee in the upper strata of Safford's formation 3 (most probably Chazy), and the others at various places in Vermont, Canada East and Newfoundland. The distance from Highgate Springs, in a straight line, to the village of Chazy the typical locality of the formation, is about seventeen miles in a westerly direction. Chazy limestone is said to occur on Isle La Motte, in Lake Champlain about twelve miles south-west of Highgate Springs. It would require a great deal of further examination of the locality at Highgate Springs in order to determine positively whether the true Chazy exists there, and if it do, what is the difference, in the grouping of the fossils between that and the typical locality, that might be due to geographical distribution.

Within two miles east of the exposure of Trenton and Black River limestone at Highgate Springs, we come to a large tract of limestone, of the Quebec group, which extends north to Bedford, a distance of about ten miles with a width of two miles at Phillipsburgh. A great many fossils occur in this tract of limestone, but not one of them has yet been identified as a Black River or Trenton form, and yet these two formations with a considerable number of their peculiar and characteristic species are exposed within two miles. Here then, as at Quebec, the theory of distinct zoological provinces will not explain the difference between the fauna of the Quebec group, and that of the Trenton and Black River.

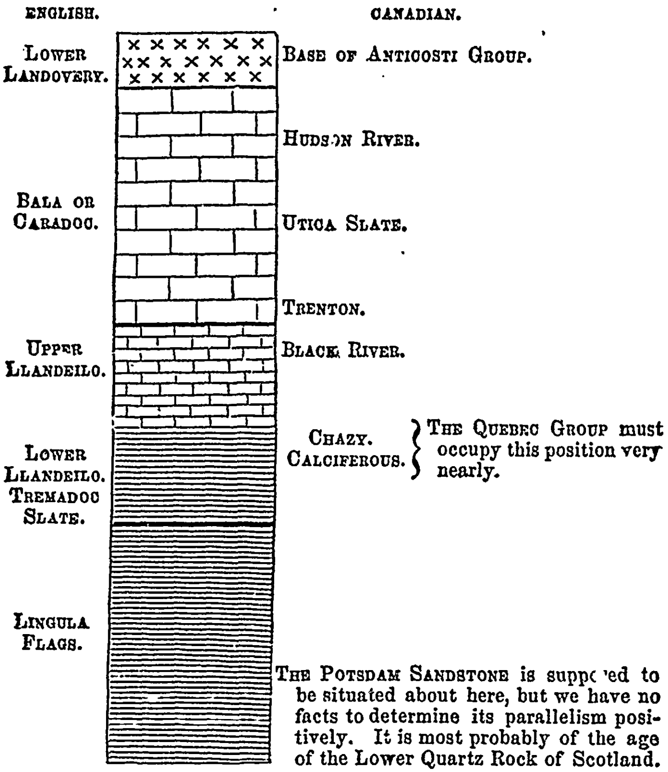
The above is intended to show, that the Quebec group is not of the age of the Trenton, and that its upper limit cannot be higher than the base of the Black River. It is useless to compare it with the Hudson River, or any other higher formation. I think, however, that it must come very near the Black River, and, in describing the new species from Phillipsburgh, I have (in giving the locality and formation at the end of each description) referred them either to the "*upper part of the Calciferous formation*," or to "*beds holding fossils approaching in aspect to those of the Chazy or Black River formations.*"

The upper limits of the Quebec group, having been determined as above, it remains next to show how far it extends downwards. On this point I have only to say, that in Newfoundland, Mr. Richardson has discovered a series of rocks, which I have not the least hesitation whatever, in pronouncing to be positively identical in age with both the Loint Lévis and Phillipsburgh limestones. He has also ascertained, by a good coast section, that they clearly overlie all that part of the Calciferous which holds the remarkable and characteristic cephalopods of Mr. Salter's new genus *Piloceras.* These beds in their turn overlie conformably the sandstones holding *Lingula acuminata,* which characterizes the upper strata of the Potsdam, in Canada West, New York, and Wisconsin. We thus have two horizons well determined, between which the Quebec group (or at least that portion of it to which the Point Lévis and Phillipsburgh limestones belong) must be situated. The lower horizon is about the middle of the Calciferous, and the upper near the base of the Black River limestone.*

It follows from what has been above stated, that the Chazy limestone occupies a position between the same two horizons which limit the Quebec group above and below. Are these two formations *i.e.*, the Chazy and the Quebec group, of the same age? On this point all that can be said is that the Quebec group holds about 300 species of fossils (including the graptolites), and I cannot identify a dozen of them with true Chazy species. My own view is, that in a portion of the Quebec group, we have a set of strata representing those which are absent in Canada, west of the line where the break occurs between the Calciferous and Chazy formations. The remainder may possibly be of the age of the Chazy, the difference in the species being due to geographical distribution. I only offer this however as a possible solution of one of the difficulties that have been met with, in endeavouring to arrive at the truth, in this complicated question.

* It is possible that the lower part of the true Calciferous may be represented by some of the slates in the south-eastern region in which no fossils have yet been found.

DIAGRAM SHEWING THE SUPPOSED PARALLELISM OF THE ENGLISH AND CANADIAN LOWER SILURIAN FORMATIONS.




Below the LINGULA FLAGS in England are situated the CAMBRIAN (Sedgwick), beneath which the LAURENTIAN (Logan) occurs in the North of Scotland.

In Canada, we have below the POTSDAM, the HURONIAN (Logan), and beneath that, the LAURENTIAN.

In England the Potsdam formation has not I believe been clearly identified; but in Scotland, Sir R. I. Murchison has shewn in several papers, published in the Journal of the Geological Society, that it is represented by the Lower Quartz Rock of Sutherlandshire. It is there overlaid by the Durness limestone, which has been identified by him and by Mr. Salter as of the age of the Calciferous formation. I have seen the fossils collected by them, and think that their opinion is undoubtedly correct. In Canada, the Quebec group with its compound graptolites, overlies all those rocks which represent the Durness limestone.

The Black River and Trenton limestones, the Utica slate and Hudson River of Canada, represent the upper half of the Lower Silurian of England, but the sub-divisions recognized in the two countries cannot be exactly paralleled. It is almost certain that the Hudson River represents a portion of the Bala or Caradoc. I think that the Trenton limestone might well be paralleled with the base of the same group. The Black River may be nearly parallel with a part of the Bala and the highest strata of the Upper Llandeilo.

I shall now notice briefly Mr. Marcou's last publication,* in which the following section is given in descending order:

| | | |
|---|---|---|
| 1. Potsdam Sandstone.............. | 300 | feet. |
| 2. Quebec Group.................... | 2,400 | " |
| 3. Point Lévis Group.............. | 1,000 | " |
| 4. Gilmour Group.................. | 400 | " |
| 5. Chaudière Group................ | 3,000 | " |

No facts either physical or palæontological are given by Mr. Marcou in support of the above classification. It is purely conjectural. He places the limestones and slates of Point Lévis and Phillipsburgh, which have yielded nearly all the fossils of the Quebec group yet discovered, in what he calls the Point Lévis and Gilmour groups, the highest beds of which are according to his section 2400 feet below the base of the Potsdam sandstone. From these rocks we have in the Provincial Geological Museum at Montreal the following genera of organic remains:

Genera of the Quebec Group.

*Eospongia*, *Stenopora*, *Tetradium*, *Petraia*, *Rhodocrinus*, *Glyptocrinus*, *Palæocystites*, *Dictyonema*, *Graptolithus*,† *Obolus*, *Obolella*, *Lingula*, *Acrotreta*, *Leptæna*, *Strophomena*, *Camerella*, *Rhynchonella*, *Cyrtodonta*, *Holopea*, *Subulites*, *Murchisonia*, *Eunema*, *Pleurotomaria*, *Helicotoma*, *Ophileta*, *Maclurea*, *Ecculiomphalus*, *Metoptoma*, *Bellerophon*, *Orthoceras*, *Cyrtoceras*, *Lituites*, *Nautilus*, *Æglina*, *Agnostus*, *Amphion*, *Ampyx*, *Arionel-*

---

* *Letter to Mr. Joachim Barrande, on the Taconic Rocks of Vermont and Canada*; by Jules Marcou, Cambridge, Massachusetts, August, 1862.

† There are several sub-genera of *Graptolithus*, but as the Decade in which they are to be described is not yet published, I am unable to name them with certainty.

*lus? Asaphus, Bathyurus, Cheirurus, Conocephalites? Dikelocephalus, Endymion, Harpides, Holometopus, Illænus, Leperditia, Lichas, Menocephalus, Nileus, Olenellus,* and *Shumardia.*

Any one who has studied the palæontology of the older rocks will perceive that the above is a Silurian fauna. Out of fifty-three genera there are only seven which have a primordial aspect. They are the following:

| | |
|---|---|
| Agnostus, | Arionellus, |
| Bathyurus, | Conocephalites, |
| Dikelocephalus, | Menocephalus, |
| Olenellus. | |

These seven genera are just sufficient to give to so large a fauna a perceptible primordial tinge, so to speak, indicating a proximity to the base of the Lower Silurian. Of the species there are ten or twelve considered to be identical with well known Calciferous and Chazy forms; and about as many more which are closely allied to some of those occurring in these and some of the overlying formations. I have marked the genera *Arionellus* and *Conocephalites* doubtful, as it is not quite certain that *A. cylindricus, A. Sedgwicki,* and *C. Zenkeri** are sufficiently determined. It makes little difference however, as the species have a primordial aspect.

There is no palæontologist in America who will ever believe that we have in Canada a formation lying 2400 feet below the base of the Potsdam, holding a fauna composed of the genera given in the above list. No English palæontologist will believe that such a fauna is to be found in rocks older than the Lingula flags. Barrande will certainly not admit such a fauna into his Primordial Zone. Dr. Emmons will not take the Point Lévis and Phillipsburgh limestones into his Taconic system. In several letters which I received from him in 1860 after the first publication of the Quebec fossils, he says that he considers the Point Lévis limestone to be the Lower Silurian and of the same age nearly as the limestone of Troy, Bald Mountain, Mount Toby and other places in New York. But he seems to claim the slates which hold the graptolites. Barrande, however, both in his published papers and in his letters to me, steadily refuses to admit the graptolites into the primordial zone. Sir R. I. Murchison also maintains with Barrande that all graptolitic rocks are Silurian.

* This species may belong to the genus *Harpides.*

As the Point Lévis and Phillipsburgh limestones are thus turned out of the Taconic system by Emmons, and the graptolitic rocks of the same localities refused admission into the primordial zone by Barrande, Mr. Marcou will experience much difficulty in maintaining his classification.

Apparently in anticipation of this difficulty, he says, that the limestones in question, are centres of creation, and that the fossils are groups of Lower Silurian types which made their appearance in the ocean during the primordial period. They are thus Silurian colonies in the primordial zone. But he does not give any facts in proof of this theory. He seems to ignore the inflexible rule to which every investigator must submit, that he who advances a new proposition in science, must furnish the public with the proof. He has the affirmative side of the question, and the *onus probandi* lies upon him. Thus, in endeavouring to point out the geological age of the Quebec group, we laid our proofs before the scientific world; we published our facts. Every fossil species described and figured, is a natural fact, upon which a scientific man may reason, and from which he can draw conclusions. The first step Mr. Marcou must take, in order to establish his classification, is to prove that the slates, in which the lenticular masses of limestones holding his colonies are imbedded, belong to the primordial zone. He can only do this, by palæontology, or, by physical geology. A vast proportion of these slates hold no fossils at all, or at least, none have been found in them; and therefore their age cannot be determined by palæontology. The remaining portion do, it is true, hold fossils, but they are not primordial; they are all either Lower Silurian types, or such as are common to the first and second faunæ. In addition to the graptolites we have *Obolella desiderata*, *Lingula Irene*, *L. Quebecensis*, *Orthis*, (two species one of which seems to be *O. electra*, and the other *O. gemmicula*, *Strophomena*, (1 species) *Shumardia granulosa*, and a new species of *Asaphus* with a ribbed pygidium like that of *A. Canadensis*. There are as I am informed between forty and fifty species of graptolites belonging to several genera. I have also a specimen of an obscure fossil which may be a *Tetradium*. According to palæontology this group of fossils belongs to the second fauna, and is not primordial. It furnishes therefore a point-blank contradiction to Mr. Marcou's classification. It must be borne in mind, that these slates, are not of the same age as those of Georgia in Vermont, which are characterised by the presence of the trilobites *Olenellus Vermontana, O. Thompsoni*, &c. These latter are primordial and belong to the Potsdam group. They may very properly be placed in the Taconic system, but they lie far below the Quebec group.

As Mr. Marcou can derive no aid from palæontology in support of his classification, he must establish it by physical geology. He must point out some place where the Potsdam can be seen overlying the Quebec group, as represented in his section. The locality must exhibit the rocks in their natural position. There must be no disturbances, such as faults and overturns. Now, at Quebec, not only are the strata wonderfully contorted and faulted, but further, Mr. Marcou says he could not find any Potsdam there at all. He says on page 13 of his published letter to Barrande :

"The Potsdam Sandstone does not exist in the district of Quebec, and I did not see a single trace of it north of the Grand Trunk Railroad from Richmond to Montreal. Probably if these rocks were ever deposited in that region, not finding any point of resistance close by, as in the Adirondack country, *they slipped under all the other strata in the overturn of the Taconic*, and have been entirely concealed from view by the succeeding groups."

If the Potsdam be concealed from view at Quebec, how does he know that it overlies the Quebec group? In the above quotation I have italicised a few words, because at p. 10 he informs Barrande that the strata at Point Lévis are not much disturbed, "and that the few foldings in the strata of the Ferry Cliff, are mere accidents, confined to a distance of a few feet, and are without any effect upon the whole mass of strata, but are, what we call in French, *structure ployée* (contorted beds). This does not agree very well with the asserted overturn. According to my view, when a huge formation of rock, more than a mile in thickness, and occupying many thousand square miles in geographical extent, has been turned completely upside down (as Mr. Marcou says his new Taconic system has been) by some tremendous convulsion of nature, the structure must indicate a very considerable amount of disturbance.

Passing now from Quebec to Phillipsburgh and Swanton, Mr. Marcou, has given us another section to indicate the succession at these two latter localities. It is as follows in descending order :

| | | |
|---|---|---|
| 1. | POTSDAM SANDSTONE,............... | 300 feet. |
| 2. | SWANTON SLATES,.................. | 2000 " |
| 3. | PHILLIPSBURGH GROUP,............. | 1300 " |
| 4. | GEORGIA SLATES,.................. | 400 " |
| 5. | ST. ALBAN'S GROUP,............... | 3000 " |

No. 4 of this group is primordial, but No. 5, the St. Albans' group, is very obscurely, or not sufficiently defined, to enable us to recognize it. No. 3 consists of a large tract of stratified limestone ten miles in length, and (opposite Phillipsburgh) two miles wide. The strata, in general, dip easterly at an angle of from 12° to 25°, but in many places the dip is much steeper and in a different direction. It is not an accumulation of lenticular masses, as Mr. Marcou calls it, but a large tract of regularly stratified limestone. Its thickness, measured across the outcropping edges of the strata, is about 1500 feet. It holds numerous fossils, mostly identical with those of the Point Lévis limestones. The slates called by Mr. Marcou Swanton slates., and placed, in his section, above the limestones and below the Potsdam, are, in great part, destitute of fossils. A few graptolites have been found in them by the Rev. Mr. Perry, Dr. Hall (both of Swanton), and myself. They are thus, according to palæontology, not primordial slates. Here then, as at Quebec, palæontology affords Mr. Marcou no assistance, but strong opposition instead. Physical geology does not aid him in placing the Potsdam above the slates because neither at Phillipsburgh nor at Swanton is there any of the Potsdam within a mile of them. How then does he know which of the two formations is uppermost? The only place where these slates can be seen in this neighbourhood, in contact with any other formation, is at the village of Phillipsburgh, and here they underlie the limestones. They form the lower thirty feet of the cliff along the water's edge, commencing at Strite's Hotel. Yet Mr. Marcou places them above the limestones. If he is right, then there must be a great dislocation here.

Mr. Marcou says, that last year, he remained only a few hours at Phillipsburgh and that he adopted, without examination, the opinions expressed by me in my paper on the age of the Phillipsburgh limestones, referring them to the Calciferous and Chazy. "But, he says, "a careful survey this year has convinced me that at Philipsburgh, as well as at point Lévis, Mr. Billings has been misled in giving explanations, and arriving at conclusions, in his palæontological researches, which are *entirely at variance with what exists in nature.*" In answer to this I shall only say that I studied the natural facts that were laid before me, *i. e.*, the fossils, according to the principles established by the great masters of palæontology, such as Cuvier, Barrande, Agassiz, and others; and I do not fear for the result. If he had done the same he never would have placed the Quebec group below the Potsdam. As he has published and circulated a letter addressed to Barrande, containing the above remarks, he is bound, in honor, to publish Barrande's answer, and circulate that also. If he do not, then we must believe that Barrande does not coincide with him.

From Pillipsburgh, a range of exposures of limestone, runs southerly to St Albans Bay in Vermont, a distance of about twenty miles. Some of these small tracts of limestone are Trenton, while others may belong to the Quebec group. At St. Albans Bay there is a cliff or ridge, of reddish magnesian limestone and sandstone, running north and south, nearly parallel to, and a short distance from the shore. This I believe to be the Potsdam. A road, from the town of St. Albans down to the Bay, crosses this ridge at a right angle, passing through a wide irregular ravine. North of the road there is an exposure of greyish or whitish limestone at the foot of the cliff, which may belong to the Quebec group. It seems to plunge under the sandstone, as it is exposed within ten feet of it and dips towards it. In this limestone I found a *Pleurotomaria* very like one that occurs in the Quebec group. This place, might be appealed to as affording proof, that the Potsdam overlies the Quebec group physically. But I think there is a dislocation here. The Potsdam dips easterly at a gentle angle, but the limestone is greatly disturbed, and is in some places vertical. Again, following the base of the cliff southerly across the road we soon come to another exposure of limestone of a different age. It is dark grey, blue and black and often traversed by seams of white calc-spar. The stratification is much confused, thus indicating the promixity of a fault. Some of the beds hold *Stenopora fibrosa*, *Strophomena alternata* and *Asaphus platycephalus*. These are either Trenton or Black River. In one place the weathered surfaces exhibit sections of *Pleurotomaria* and *Maclurea* and may be Chazy. It seems to be underlaid by a black slate. The rocks of this exposure also seem to plunge under the Potsdam, as do those north of the road.

The Potsdam at St. Albans Bay thus comes in contact with two different formations, within a distance of half a mile. According to Mr. Marcou's section there ought to be here 2000 feet of slate between the limestone and Potsdam. I think that all the facts, both palæontological and physical, that can be observed here, indicate the existence of a great fault, with an upthrow on the eastern side.

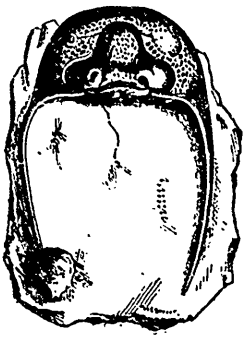
About twenty-five miles further south, at the small promontory called Sharp-shins, or Lone-rock Point, at Burlington, a formation of limestone, which appears to belong to the Potsdam, is seen resting on black slate, the contact being visible. In the debris of broken slate, at the foot of this cliff, the Rev. Mr. Perry found some imperfect fossils. Among these I recognized a fragment of *Conularia*, and the punctured border of the head of a *Trinucleus*, As the fossils were found loose, the age of the slates is not determined palæontologically. But I have shown (Am. Jour. Sci., 2d Sep., Vol. 33, p. 102) that the underside of the limestone, or the surface of it which is in contact with the slate, is smoothed, and presents very much the appearance of slickensides. There are thus at this place also indications of a dislocation.

At Buck mountain, still further south in Vermont, I have also shown (Soc. Cit., p. 103) that the Potsdam is brought up by a fault (with an upthrow on the east side) against the Chazy and Black River. I think the limestone at the north end of this mountain belongs to the Quebec group.

At Snake mountain, about a mile further south, the Potsdam has about 700 feet of black slate below it. But as the undoubted Chazy limestone is seen at the foot of the hill, apparently plunging under the slate which supports the Potsdam, there must inevitably be here (as Dr. Emmons has long held) one or more great faults. No fossils have been found in the slates at this locality, *i.e.*, in those that have the Potsdam above them.

All the evidence, both physical and palæontological, thus far collected, seems to show that (in the disturbed region of the south-eastern portion of the palæozoic basin of North America) *whenever the Potsdam, with its primordial fauna, appears to overlie rocks holding the types of the second fauna*, there will be found some evidence of a great fault, often with an overlap, by which the older rocks are not only brought up to a level with the newer, but even shoved over them. This solution of the great problem, which for twenty years has been so much discussed by American geologists was first brought out by Sir W. E. Logan, in Dec., 1860, and all the new facts ascertained since then, along the line of the fault, prove that it is the only true one that has yet been advanced.

*Description of a new species of Harpes from the Trenton Limestone, Ottawa.*



HARPES DENTONI. (N. SP.)

(The glabella is distorted in the posterior half.)

*Description*:—The head of this species, exclusive of the posterior prolongation of the border, is nearly semi-circular. The border itself is not wholly preserved in the specimen, so that its width cannot be ascertained. The length of the head without the border is six lines, and its width on a line running across the neck segment fone inch. The margin is prolonged backwards thirteen lines from the neck furrow. The head is rather strongly convex, its elevation at about mid-length of the glabella being about four lines in the specimen, although a little depressed by distortion. The glabella is strongly convex being elevated nearly one line above the level of the cheeks; it is obtusely rounded in front, and appears to be nearly as broad where a line drawn through the eyes crosses it as it is at the neck furrow, but on this point there is some doubt as the posterior portion is crushed. The neck furrow is well defined across the glabella, and curves a little forward on the median line. The neck segment is well developed. On each side of the base of the glabella, there is an irregularly semi-oval space, the outer margin of which, is abruptly sunk about half a line below the general surface of the cheeks. This space is bordered on its posterior margin by the neck furrow;—on the outer and anterior side, by a nearly vertical elevation of the crust of the cheek, the outline of the space making an obtusely rounded curve on the outside and then turning inward and forwards to the glabella, which it reaches at an acute angle on a line crossing the eyes. There appears to be slightly impressed glabellar furrow on each side, which commences at about one line from the neck furrow, at about one third the width of the glabella from the side of the same, and runs obliquely forwards and outwards, reaching the side at about one line behind the eye. In front of this, there appear to be, two small depressions in the side of the glabella close to the surface of the cheek and opposite the eye. A line drawn across the head through the eyes would cross the glabella at about one third its length from the front. The eyes are small tubercles, scarcely half a line in diameter, and situated about two lines from the side of the glabella. A small thread like ocular ridge runs from the eye forward, nearly to the front of the glabella, but does not appear to cross the small dorsal furrow which runs round the sides and front. The neck segment forms a vertical elevation along the the posterior margin of the head, half a line in height and curving backwards gradually passes into the posterior prolongations of the head. These as far as they can be seen are nearly vertical, but sloping a little inwards and upwards.

The surface of the whole head is covered with small irregularly polygonal pits separated from each other by sharp edged walls. On the cheeks these pits are on an average about one fourth of a line across, but they vary in size, some of them being much smaller than the others. They seem to be in general a little smaller on the glabella than on the cheeks. Where a portion of the crust is broken away, from the front of the head, a cast of the inner surface can be observed. It is covered with small round tubercles, about three in one line.

This species differs from *Harpes antiquatus*, the only species hitherto described from the Lower Silurian Rocks of Canada, in having the glabella more obtusely rounded in front, and in the remarkable characters of the surface which is reticulated, all over the head, by the sharp lines separating the angular puncture, while in *H. antiquatus* the glabella is smooth or only minutely punctured.

Dedicated to Mr. William Denton, of Painesville, Ohio, who discovered it.

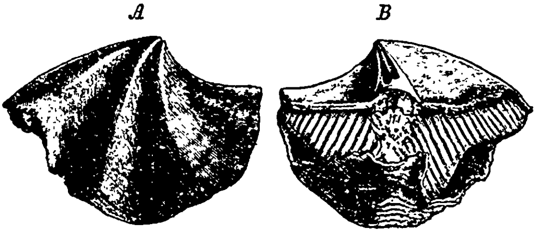
*Locality and Formation.*—Ottawa, Trenton limestone.

*On the Internal Spiral Coils of the Genus Cyrtina.*

Mr. Davidson, in his monograph on the British Carboniferous

Brachiopoda, p. 68, points out, that no spiral coils had been noticed in the genus *Cyrtina* by any author. By working at some silicified specimens with acid, I have been so fortunate as to discover these organs in two species. Their position is the same as in *Spirifera*, but the first two coils are (at least in one of the species, *C. Dalmani*, Hall) connected a little in front of the midlength by an apparatus somewhat like that of *Spirigera*, but not so complicated. A very slender process springs upwards towards the ventral valve, from each coil, and at the height of about one line, curves forwards. The two then unite, and form a single band, which extends forwards to about the front of the coil, and there ends in an obtuse point. This connecting process I have only seen in one specimen of *C. Dalmani*. The other species appears to be new, and I shall describe it under the name of

CYRTINA EUPHEMIA. (N. SP.)




*Cyrtina Euphemia*, (N. sp.) *A*, ventral view, *B*, dorsal view, shewing the area and spiral coils.

*Description.*—Shell rather large; ventral valve moderately convex, irregularly depressed pyramidal, sub-semi-circular, the margin undulated in its outline by the large radiating folds; mesial sinus commencing in a point at the beak, and gradually enlarging so that its width at the front margin is equal to nearly one third the whole width of the shell at the hinge line. On each side of the mesial sinus, a single large rounded rib or fold, nearly equal to the width of the sinus, becoming angular near the beak. Near the cardinal edges there are two other obscure depressed convex folds, one on each side. Area concave, at right angles to the plane of the margin in the lower third, but incurved in the upper two thirds. Beak minute, pointed and incurved a little over the cardinal edge. Foramen narrow, its width at the hinge line equal to half the height of the area, closed by a thin convex deltidium in the lower half; in the upper half, open and shewing, within, the thin plate which partially divides the triangular chamber of the ventral valve. In the only specimen collected, the beak and area are distorted being turned to the left. This is not the result of pressure, but owing to an irregularity in the growth of the shell.

Dorsal valve moderately convex with a large rounded mesial fold, and two others obscurely developed, one on each side.

Surface not well preserved in the specimen, but apparently smooth with some lamellose lines of growth. In one specimen the shell appears to have an inner coarsely punctate layer.

The spires at their bases, or where the two cones abut against each other, base to base, extend from the hinge line to the front margin, but they rapidly diminish in diameter outwards and become sub-cylindrical near the cardinal angles.

The specimen when perfect must have been at least 18 lines wide on the hinge line; length of dorsal valve 8 lines; length of ventral valve from the beak to the front margin 12 lines; height of area about 6 lines, width of foramen on the hinge line 3 lines.

Along the edge of the open part of the foramen, there are some indications that the deltidium, when perfect, extended nearly to the beak.

*Locality and Formation.*—Township of Walpole, Canada West; Corniferous limestone, Collected by J. De Cew.

---

ART. IV.—*On a new method of preparing Chlorine, Carbonate of Soda, Sulphuric Acid and Hydrochloric Acid;* by THOMAS MACFARLANE.

In a former paper * I had occasion to describe the nature of the reactions which take place on calcining iron pyrites with a small proportion of common salt. These reactions I supposed to be as follows:—First, the greater part of the sulphur of the pyrites is oxidized by the air, and disengaged as sulphurous acid, the iron also combining with oxygen and forming peroxide of iron. At a later stage of the operation, part of the sulphurous acid formed comes in contact with the peroxide of iron, and is through its agency further oxidized into sulphuric acid, which combines with the iron oxide, forming finally a comparatively small quantity of sulphate of peroxide of iron. This salt reacts on the chloride of sodium, producing sulphate of soda and

* Canadian Naturalist for 1862, p. 194.

perchloride of iron. Air having still access, the perchloride of iron is resolved into peroxide of iron and chlorine gas, which latter escapes, and may be recognized by its odor as soon as the evolution of sulphurous acid has ceased. Assuming this explanation to be correct, it occurred to me that chlorine might be produced on a large scale by taking advantage of the reactions which occur towards the end of the process above described, and by substituting common green vitriol (calcined) for the sulphate of peroxide of iron formed by the reactions just mentioned.

I found however on calcining a mixture of four parts of calcined green vitriol (the formula of which may be regarded as $Fe_2\ O_3$, $2\ SO^3$) and three parts of common salt, in a muffle furnace, at a moderate red heat, that these substances fused together, and evolved, instead of pure chlorine, a mixture of this gas with vapors of perchloride of iron. I then prepared perchloride of iron by heating together calcined green vitriol and chloride of calcium over a spirit-lamp. In this reaction the materials did not fuse together, and the perchloride of iron sublimed from the mixture was decomposed at a gentle heat in the muffle into chlorine and peroxide of iron. It was also decomposed when heated with peroxide of manganese over a spirit-lamp, pure chlorine being evolved. On heating a mixture of calcined green vitriol and common salt in the same way, it fused, but gave no sublimate, nor was there any chlorine evolved on heating the same mixture with peroxide of manganese. On the other hand, a mixture of calcined green vitriol, chloride of calcium, and peroxide of manganese heated over a spirit-lamp did not fuse nor agglutinate, and gave off chlorine abundantly. From these experiments it seemed essential in order to the production of chlorine from calcined green vitriol and common salt, that these materials should be kept in a loose and porous condition, in which state the oxygen of the atmosphere might more readily permeate the mass. I accordingly added to the mixture of four parts of calcined green vitriol and three parts of common salt, an equal weight of peroxide of iron, and heated the mixture in the muffle. The fusion of the materials was thus prevented, and an abundant evolution of pure chlorine took place. On continuing the calcination until chlorine was no longer evolved, I found that the residue consisted almost exclusively of sulphate of soda and peroxide of iron. The solution obtained by treating it with hot water contained no iron. I then took 474 grains (3 equivalents) of calcined green vitriol, 351 grains (6 eq.)

of common salt, and 702 grains (9 eq.) of peroxide of iron (a lesser proportion than in the former experiment), mixed them intimately and introduced them into a glass flask, heated by a spirit-lamp. By means of an aspirator of caoutchouc, I drew a current of air, not previously dried, over the heated mixture, and then successively through water, dry hydrate of lime, and a solution of caustic potash. The latter at the close of the experiment gave with hydrochloric acid no odor of chlorine, but the hydrate of lime similarly treated evolved abundance of it, and indeed possessed all the properties of bleaching powder. The production of chlorine and bleaching powder was therefore in this case accomplished, but the large quantity of peroxide of iron remaining in the residue rendered this unfit for the further treatment required for the manufacture of carbonate of soda. I accordingly sought to reduce to a minimum, the quantity of peroxide of iron to be added to the other ingredients, and found that a mixture of 316 grains (2 eq.) of calcined green vitriol, 234 grains (4 eq.) of common salt, and 312 grains (4 eq.) of peroxide of iron was capable of being calcined under the muffle, at a low red heat without melting, and yielded pure chlorine. On continuing the calcination until no more of this gas was evolved, the residue contained in 100 parts:—

| | |
|---|---|
| Peroxide of iron | 65.9 |
| Sulphate of soda | 31.1 |
| Chloride of sodium | 3.0, by difference. |
| | 100.0 |

Encouraged by this result, I diminished still further the quantity of peroxide of iron used, and the temperature employed during the calcination. 316 grains (2 eq.) of calcined green vitriol, 234 grains (4 eq.) of common salt, and 156 grains (= 2 eq.) of ferric oxide yielded chlorine; on calcination in the muffle, and left a residue weighing 573 grains, and containing in 100 parts:—

| | |
|---|---|
| Peroxide of iron | 54.0 |
| Sulphate of soda | 42.1 |
| Chloride of sodium | 3.9, by difference. |
| | 100.0 |

After this I performed two additional experiments with the following proportions of materials:—

| | I. | II. |
|---|---|---|
| Calcined green vitriol | 316 | 450 |
| Common salt | 234 | 351 |
| Peroxide of iron | 78 | 78 |

The muffle was kept at a faint red heat, and in both cases chlorine was abundantly evolved. Finally I found that it was even possible to calcine 316 parts of calcined green vitriol and 234 parts of common salt, without any admixture of peroxide of iron, and to obtain an abundant disengagement of chlorine. In this case however the muffle was not allowed to attain even the faintest redness. Even at this low temperature the materials sintered together slightly. I had thus by this series of experiments ascertained the exact conditions most favorable to the disengagement of chlorine from a mixture of calcined green vitriol and common salt, and proved that the explanation given above of the production of chlorine in calcining iron pyrites with common salt was the correct one. In the course of these experiments I was also led to expose chloride of manganese to a moderate red heat in the muffle, in presence of a current of air, as in the above trials. I found that that substance in an impure state, (prepared by evaporating to dryness the residue from the preparation of chlorine from peroxide of manganese and hydrochloric acid,) was in this way converted into an oxide of manganese of a higher degree of oxidation than the protoxide, with abundant disengagement of chlorine. The decomposition was easily effected, still it seemed as if peroxide of iron, or manganese, when mixed with the impure chloride of manganese, accelerated the evolution of the chlorine. The residue from the decomposition of the impure chloride of manganese, if exposed in the muffle until the evolution of chlorine was no longer observable, yielded chlorine when heated with hydrochloric acid, but none when heated with sulphuric acid. This last reaction proved that no undecomposed chloride of manganese was left in the calcined residue.

The residue from the production of chlorine from calcined green vitriol and common salt, consisting of a mixture of sulphate of soda and peroxide of iron, on being mixed with powdered coal or charcoal, and ignited, fuses readily, and the resulting product, when treated with water, affords an alkaline solution, colored green, by dissolved sulphuret of iron, and an insoluble residue, of finely divided sulphuret of iron. This alkaline solution when exposed to the influence of carbonic acid and oxygen, becomes decolorised, and yields on evaporation carbonate of soda. This method of producing soda was proposed as early as the year 1778, by Maleherbe, a Benedictine monk, who however used metallic iron instead of the peroxide; and is the same in principle as that patented in Great Britain, by Blythe and Kopp, in 1856. These patentees prevented the partial solution of the sulphuret of iron by the alkaline liquid, by exposing the melted material to the action of carbonic acid and atmospheric air previous to treating it with water. I have however found that in the simple evaporation of the solution the decolorisation is effected by a separation of the dissolved sulphuret. In carrying out the method on the large scale, the action of the readily fused alkaline mass on the usual furnace materials is found to be very severe. In the course of my experience in refining impure arseniurets of nickel and cobalt, on the large scale, by fusing these with sulphate of soda and charcoal, I ascertained that a furnace bottom consisting principally of ground quicklime, resists the action of the alkaline sulphurets, and I found on smelting the mixture of sulphate of soda, coal and iron oxide above mentioned, in contact with a hearth of the same material, that the latter was not acted on, and thus succeeded in removing one of the greatest practical difficulties which beset this new method of manufacturing soda.

The residual sulphuret of iron from the soda process, was according to Blythe and Kopp's patent, utilised by calcining it, and conducting the sulphurous acid thus produced into the leaden chamber, for conversion into sulphuric acid, in the usual manner. This moist sulphuret of iron, however, on being exposed to air and moisture, passes through various intermediate stages of oxidation, and finally becomes very rich in sulphate of iron. As this salt finds a ready and suitable application in the new method of producing chlorine, it seemed to me the preferable mode of recovering the sulphur, to remove the sulphate of iron from the oxidized mass by lixiviation, and to evaporate the solution obtained to crystallization.

Having thus stated the manner in which this new method of making chlorine and carbonate of soda suggested itself to me, I may be permitted to state, more concisely my manner of putting the method into practice, which is as follows:—828 parts of common crystallized green vitriol, (obtained either by the ordinary methods, or in the manner yet to be described,) are heated until they part with their water of crystallization, and become more or less oxidized, without however losing any sulphuric acid. The calcined green vitriol thus obtained is then mixed with 352 parts of common salt, (previously heated until it no longer decrepitates,) and also with 78 parts of peroxide of iron, (which may readily be obtained by calcining pure iron pyrites with five per cent. of common salt) and lixiviating the result. These ingredients, in fine powder, being intimately mixed, are introduced into a muffle calcining furnace, nearly of the same construction as that used in Europe for calcining arsenical pyrites. The mixture is spread over the hearth of the furnace, which is heated to faint redness by a fire placed underneath it. That part of the furnace over the hearth, which may be called the muffle, and to which the flames, or products of the combustion of the fuel have no access, is connected with an exhausting machine, which draws a current of air, (previously dried, by passing through quicklime), over the mixture which is spread out on the hearth of the furnace. A decomposition takes place at a very low temperature, between the sulphate of iron and the chloride of sodium, sulphate of soda resulting on the one hand, and protochloride and perchloride of iron on the other. The temperature in the furnace is so low that neither of the chlorides of iron is sublimed; but on the other hand the oxygen contained in the dry air passing over the mixture, converts both into peroxide of iron, which remains behind, and chlorine gas, which is drawn off by the exhausting machine. It is of the utmost importance in this operation, that the temperature be kept as low as possible, because anhydrous sulphate of iron and chloride of sodium heated together, to a higher temperature, fuse and emit fumes of perchloride of iron. In order therefore to obtain pure chlorine, the mixture must not be permitted to fuse, or even to sinter. The peroxide of iron in the mixture has some influence in preventing fusion, and in eliminating the chlorine. The greater the quantity of peroxide of iron used, the more easy it is to calcine the mixture without its caking together. I have not found it necessary however to use more than the proportion above stated, when the calcination is performed with proper care. During the operation, the materials are gently but frequently stirred with an iron rake; this also prevents sintering. I have found that in this operation thus conducted, the whole of the chlorine contained in the common salt is liberated in the gaseous state. By means of the exhausting apparatus, the chlorine, together with the nitrogen of the atmosphere, which is not absorbed by the mixture, is drawn, first through a layer of coke kept moist by water trickling over it, and then through lime slaked to a dry powder, somewhat in the same manner as common illuminating gas is passed through the dry lime purifier. The gases are freed by the water from any muriatic acid they may contain, and the chlorine is then quickly absorbed by the lime, and bleaching powder, or chloride of lime obtained. In the furnace there remains a residue consisting of about 427 parts of sulphate of soda and 312 parts peroxide of iron, which is withdrawn and treated in the manner about to be described. This production of chlorine and bleaching powder, and of a residue of sulphate of soda and peroxide of iron, may be called the first part of the new process.

This mixture of sulphate of soda and peroxide of iron is next mixed with 144 parts of powdered coal or charcoal, and is then introduced into a reverberatory furnace, the hearth of which has been previously prepared in the following manner: 100 parts of ground quicklime are mixed with 16 parts of basic slag, such as commonly produced in copper-smelting works, or of any other slag or glass not too difficult of fusion. This mixture is beaten into the bottom of the furnace, when in a dry state, the depression is then scooped out in it, and the tap-hole formed through it at the bottom, as is customary in preparing the hearths of furnaces intended for smelting. The furnace is now gradually heated up, and a strong heat continued, until the materials of the hearth have slightly caked together. As soon as this takes place a mixture of 100 parts of sulphate of soda and 25 parts of powdered coal or charcoal is introduced. This soon fuses and is totally absorbed by the hearth. More of the same mixture is then introduced, and this continued until no more of the resulting sulphuret of sodium is absorbed by the hearth. The furnace is then kept at a red heat, and is ready to receive the mixture of sulphate of soda, peroxide of iron and charcoal or coal already referred to. As soon as this mixture has entered into quiet fusion it is drawn off by the taphole into iron moulds or wheel-barrows, in which it solidifies, in large blocks. It is totally without corrosive action on the hearth; and an almost unlimited number of charges may be smelted down, without the hearth being at all affected. This on the contrary becomes and remains hard and compact, and can only with difficulty, be taken out of the furnace. These blocks of smelted material, which contain sulphur, sodium and iron, are immediately broken up, and introduced in a boiler exactly similar to that used for evaporating alkaline solutions in the ordinary method of manufacturing soda, in which the furnace is placed at one end, and the flame and products of combustion pass over the surface of the solution. On the introduction of the smelted material into the water, it is partially dissolved, and the solution assumes a deep greenish color, from dissolved sulphuret of iron. When however heat is applied, and the carbonic acid from the furnace produced in the combustion of the fuel, is passed over the surface of the solution, it is gradually decolorized, carbonic acid and oxygen being absorbed, and becomes a solution of carbonate of soda with caustic soda. In the event of the solution being too much evaporated before the decolorization is effected, water is added, and the heating and exposure to the carbonic acid and air continued. During the whole of this operation the insoluble sulphuret of iron remains at the bottom of the boiler. When the supernatant solution has become colorless, the heat is discontinued, and the contents of the boiler allowed to settle. The clear liquid is then drawn off by means of a syphon or stop-cock, and water is added to residue. If this solution also becomes green, it is decolorized in the same manner as the first. This second solution is then drawn off in the same manner, and the operation repeated with fresh water, until the latter dissolves no more soda from the residue. The first and more concentrated solutions thus obtained are evaporated to dryness, the product is heated in a carbonating furnace, and crystallized carbonate of soda and soda-ash obtained from it in the usual manner. The weaker solutions are used for treating fresh quantities of smelted material from the furnace. The sulphuret of iron which remains after having been thus repeatedy washed with fresh water-is run off from the bottom of the boiler into a large wooden box, having a perforated false bottom over which a linen cloth is spread. The greater part of the water here drains off and the sulphuret of iron is then fit to be treated in the manner next to be described. This production of carbonate of soda and of soda, ash may be termed the second part of the process.

The insoluble sulphuret of iron obtained as above described, while still in a moist state, is exposed, with as much surface as possible, to the action of the air and of moisture. It is placed on a perforated wooden floor covered with cloth, and supported over an impervious bottom of clay or other material, so inclined and arranged that the solution obtained in lixiviating the mass may be conveniently collected for further treatment. The moist sulphuret rapidly oxidizes, and passing through various intermediate stages of oxidation, it ultimately becomes very rich in sulphate of iron. It must never be allowed to oxidize so rapidly as to enter into combustion, because in that case sulphurous acid is produced, which would escape as gas, and be lost. This tendency to oxidize too rapidly may be counteracted by keeping the material moist. When a sufficient quantity of sulphate of iron has been formed in the mass, hot water is poured over the whole surface. This percolating through dissolves the sulphate, and falling on the impervious floor beneath, flows into channels prepared for it, and is finally collected in a large reservoir. The solution thus obtained is concentrated in boilers of the same description as those used in copperas works, and crystals of green vitriol are obtained in the manner usually adopted in the same establishments. The exposure and lixiviation of the sulphuret is continued and repeated until a residue is left consisting exclusively of peroxide of iron, and containing no sulphur. The green vitriol obtained as above described, is used in the first part of the soda process and the residue of peroxide of iron, if sufficiently pure, may also be used in that operation. This production of sulphate of iron, and of the residue of peroxide of iron, may be called the third and last part of the process.

Having thus to some extent described the new method of preparing chlorine and carbonate of soda, I proceed to advert to the advantages which it possesses over the ordinary process. The manufacture of bleaching powder and soda, as at present pursued, comprises the following operations; 1st. The manufacture of sulphuric acid from iron pyrites or sulphur, by the action of nitrous acid on the sulphurous acid and atmospheric air admitted into the leaden chamber, which nitrous acid is produced by the action of sulphuric acid on nitrate of soda; 2nd. The production of sulphate of soda and muriatic acid by the action of sulphuric acid on common salt; 3rd. The production of chlorine (and of bleaching powder,) by the action of muriatic acid upon the peroxide of manganese, in which process however only *one half of the chlorine* contained in the muriatic acid is evolved in the form of gas, the other half combining with manganese and forming with it a waste product of chloride of manganese; 4th. The decomposition of sulphate of soda by igniting it with limestone and charcoal, in which operation the sulphur combines with lime, forming with it a waste product of sulphuret of calcium; 5th. The extraction of carbonate of soda and soda-ash from the product of this ignition. With regard to these, the ordinary processes, the following facts are to be observed.—I. The whole of the sulphur contained in the sulphuric acid, and one half of the chlorine contained in the common salt originally used are lost. II. They comprise five distinct purposes, some of which, such as the manufacture of sulphuric acid, require very expensive apparatus. III. Nitrous acid, peroxide of manganese, and limestone are used in these process, in such a manner as not to be economically recovered, or only with great difficulty. In comparing these processes with the new method it will be observed: I. That by means of the latter the suiphur combined in the sulphuric acid of the green vitirol used in the first part of the process is recovered, and may be used an indefinite number of times; and that *the whole of the chlorine* contained in the common salt is evolved as gas, and rendered available for the manufacture of bleaching powder. II. that the new method comprises only four processes, one less than by the ordinary mode, and that these do not require any extraordinarily expensive apparatus. III. That nitrous acid, peroxide of manganese, and limestone are altogether dispensed with; only one material, peroxide of iron, being used in place of the limestone, but always in such a manner as to be recovered and used again. It will of course be evident that the advantages here enumerated result to some extent from the combination of what has above been termed the three different parts of the process. They form together an independent method for making bleaching powder and soda without the intervention or auxiliary manufacture of sulphuric and muriatic acids, or the necessity of using more than the one principal raw material, viz., common salt.

With regard to the new method of manufacturing sulphuric and muriatic acids, it is based upon the following chemical reaction—when sulphuric acid and chlorine gases in the proportion of their equivalents are brought in contact with water or steam, the oxygen of the latter unites with the sulphurous acid, forming sulphuric acid, while the hydrogen forms with the chlorine, muriatic acid. The manufacture of these acids on this principle was, in 1854, embodied in a patent for Great Britain, by William Hahner.* He however proposed to prepare the chlorine in the usual manner, from peroxide of maganese and muriatic acid, and mix it with sulphurous acid and steam in the leaden chamber. The mixture of sulphuric and muriatic acids here condensed, he proposed to treat by distillation, in order to separate the two. When it is considered that double the amount of muriatic acid produced in the process must be consumed in producing the necessary chlorine, the economy of the method seems exceedingly doubtful.

The mode I propose differs from that referred to above only in the method of preparing the chlorine, which is that already described in the beginning of this paper. By placing the usual furnaces for burning pyrites or sulphur, near the furnace for producing chlorine, as described in the first part of this paper, and connecting the exit pipes from these furnaces, with each other, and with a pipe from a steam-boiler, and drawing the gases thus mixed, either by means of an artificial draught, or an exhauster, through a condenser containing coke moistened with water, a mixture of sulphuric and muriatic acids would result. This mixture concentrated in leaden vessels, would yield sulphuric acid, while from the condensation of the vapors given off in this operation, muriatic acid would result.

Another method of preparing these acids is by calcining together 59 parts iron pyrites, 58½ parts of common salt, and 324 parts peroxide of iron.† Sulphurous acid is evolved at the commencement and chlorine towards the end of the calcination, in almost the proportions necessary for forming with water, sulphuric and muriatic acids. The residue consists of 336 parts of a mixture containing in 100 parts—

| | | |
|---|---|---|
| Peroxide of iron............ | 79.5 | |
| Sulphate of soda........... | 19.2 | =4.31 sulphur |
| Chloride of sodium......... | 1.3 | ..by difference |
| | 100. | |

This process should be carried on in two calcining furnaces, of the construction already mentioned in this paper. The second furnace should not be charged with the mixture of peroxide of iron, salt, and pyrites, until the charge in the first furnace begins

* Repertory of Patent Inventions, December, 1854.

† Vide Canadian Naturalist, p. 196.

to evolve chlorine, and by the time this has ceased the second furnace will have commenced to yield that gas, and the first furnace might be charged with new materials. Thus a continuous stream of chlorine and sulphurous acid would be kept up, and on mixing these with steam, and condensing them as above described, a mixture of sulphuric and muriatic acids would result, which is to be treated as above indicated.

Actonvale, Canada East. 16 February, 1863.

---

ART. V.—*On the Land and Fresh-water Mollusca of Lower Canada*; by J. F. WHITEAVES, F.G.S., &c.

*(Read before the Natural History Society.)*

PART I.—GENERAL CONSIDERATIONS.

Various papers of interest have appeared in the Canadian Naturalist, on the distribution of the land and fresh-water mollusca in Lower Canada. We are indebted to Messrs. Billings, Bell, and D'Urban, for nearly all the information we possess on this subject. Within the last two years new labourers have entered the field, and the result has been some addition to our knowledge of the geographical range of these creatures in Lower Canada.

My friend, Mr. R. J. Fowler has collected assiduously and successfully in the vicinity of Montreal, and in the Eastern Townships. In the summer of 1861 I paid special attention to the inland mollusca of the neighbourhood of Quebec, and collected in several places in the St. Lawrence valley, from Rivière du Loup to Montreal. Last winter I endeavoured to call the attention of the members of the Natural History Society to a short consideration of this subject. On looking over this brief sketch (*vide* Canadian Naturalist, vol. 6, page 452) I find two or three errors have crept in, caused by my want of access to the proper authorities on the subject in Quebec. In the present paper I hope to be able to rectify these mistakes. I propose, partly from original enquiry, and partly availing myself of the labours of others, to collect together in one paper, all that we know of the geographical distribution of the inland mollusca of Lower Canada, up to the present date. I shall also indulge in some general speculations which the subject naturally suggests to my own mind.

Let us first consider the most obvious geographical affinities of the land and fresh-water shells of the district in question. Eleven of our Lower Canadian species occur also west of the Rocky Mountains. These are,

| | |
|---|---|
| Margaritana margaritifera, Linn. | Limnæa stagnalis, Linn. |
| Valvata sincera, Say. | " palustris, Mull. |
| Physa heterostropha, Say. | " catascopium, Say. |
| " hypnorum, Linn. | " solida, Lea. |
| Planorbis corpulentus, Say. | (= L. apicina, Lea.) |
| " trivolvis, Say. | " pallida, Adams. |

According to Mr. Binney, the Planorbis glabratus of Say also inhabits both the Pacific and Atlantic sides of these mountains, but as yet this species has not been detected in Lower Canada. Again, in this Province we have several species, partly land and partly fresh-water, which also inhabit the continent of Europe. Some of these shells, however, present slight differences, and have been considered distinct species. Thus the following unquestionably inhabit both sides of the Atlantic,

| | |
|---|---|
| Helix hortensis, Muller. | Physa hypnorum, Linn. |
| " rufescens, Pennant. | (= P. elongata, Say.) |
| " pulchella, Muller. | Limnæa stagnalis, Linn. |
| Bulimus lubricus, Mull. | (= L. jugularis, Say.) |
| Margaritana margaritifera, Linn. | " palustris, Linn. |
| | (=L. elodes, Say.) |

The following European and Canadian species may prove identical:

| *Lower Canada.* | | *Europe.* |
|---|---|---|
| Limax campestris, Gould. | = | Limax agrestis, Muller. |
| Vitrina limpida, Gould. | = | Vitrina pellucida, Muller. |
| Succinea obliqua, Say. | = | Succinea amphibia, Linn. |
| " ovalis, Say. | = | " Pfeifferi, Rossmäss. |
| Helix chersina, Say. | = | Helix fulva, Muller. |
| Physa heterostropha, Say. | = | Physa fontinalis, Linn. |
| Pisidium Virginicum, Brongn. | = | Pisidium amnicum, Muller. |
| Anodonta cataracta, Say. | = | Anodonta cygnea, Linn. |

It may be observed that a much larger percentage of the *marine* shells of the Gulf of the St. Lawrence also inhabit Great Britain and Northern Europe. Dead shells of the European Helix cellaria have been found by Mr. Fowler near gardens in Craig Street, Montreal. Helix rufescens, probably has also been introduced from Europe, and possibly Helix hortensis. The remainder would appear to be of exclusively North American origin, and confined to the region east of the Rocky Mountains.

Unio Canadensis of Lea is supposed, as yet, to be peculiar to Lower Canada. It is, however, a species but little understood and may be detected in the northern New England states. A Valvata found by Mr Bell at Matanne, and Little Lake Matapedia, and perhaps new to science, I have never found in the New England states. It resembles so closely a depressed variety of Valvata piscinalis of Europe, that I hesitate to separate it from that species. The whole of the land and fresh-water shells of Lower Canada, with these two exceptions, are also found in New England.

But in endeavouring to generalize on the geographical distribution of the mollusca in Canada, we cannot afford to ignore the additional evidence afforded by our knowledge respecting other groups of animals, and of the sister science of botany. It will be more philosophical to consider the geographical distribution of plants and animals *generally*, than to take any one isolated group of animals for *special* consideration and study.

Mr. Woodward, in his excellent "Manual of the Mollusca," has considered that the peculiarities of the molluscan fauna of Canada, are so well marked that we are justified in considering the Canadian as a distinct Natural-history province. This view I have endeavoured to show, in a previous paper, is not borne out by an increased knowledge of facts. The naturalist, looking on the map of Canada, observes an irregular peninsula stretching down to the southwest, and at its furthest extremity running parallel to the state of Ohio. From that state it is divided by Lake Erie, which at this point varies from thirty to sixty miles in width. Cutting off this peninsula (say from Georgian Bay in Lake Huron on the west, to Toronto on the east,) we have then left the greater part of Upper and the whole of Lower Canada. The animals and plants of this peninsula appear to have decided affinities with the western Natural-history province. Thus, in the museum of the Natural History Society, the few fresh-water shells from this region are well known western forms. As examples I may cite:

| | |
|---|---|
| Unio fragilis, Raf. | Unio flavus, Raf. |
| (= U. gracilis, Barnes.) | (= U. rubiginosus, Lea.) |
| " subrotundus, Raf. | " quadrulus, Raf. |
| (= U. circulus, Lea.) | (= U. lacrymosus, Lea.) |
| " costatus, Raf. | Physa gyrina, Say. |
| (= U. undulatus, Barnes.) | |

Judging from what we know of the zoology and botany of the Canadian area, exclusive of this peninsula, its fauna and flora would seem to be of a mixed character. In Dr. Hooker's essay on Arctic Plants, published in the Transactions of the Linnean Society, he includes a large part of Canada in his sub-arctic botanical province. Long before I had seen this paper, I had come to the same conclusion from the little I knew of the zoology and botany of Lower Canada. The marine shells of the Gulf of the St. Lawrence correspond remarkably with the shells of comparatively high northern latitudes in Europe: their boreal character is obvious. As indicating a sub-arctic flora, we may point out with Prof. Schouw, "the total absence of tropical families, and a noticeable decrease of forms peculiar to the temperate zone; the prevalence of forests of firs and birches; the abundance of Saxifrages, Gentians, species of Arenaria, Silene, Dianthus, and Lycopodium, the qnantity of mosses, and the number of willows and sedges." Such marine shells again as:—

Pecten Islandicus, Chemn.
Leda caudata, Donovan.
(= L. minuta, Fabr. & Mul.)
Crenella nigra, Gray.
Crenella decussata, Montagne.
(= C. glandula, Totten.)
Serripes Grœnlandicus, Chemn.
Astarte elliptica, Brown.
" compressa, Linn.
Tellina proxima, Brown.
Tellina Grœnlandica, Beck.
(=T. fusca, Say, T. Balthica, Lov.)

Cemoria Noachina, Linn.
Margarita undulata, Sow.
" helicina, O. Fabr.
Trochus alabastrum, Beck.
(= T. occidentalis, Migh.)
Scalaria Grœnlandica, Chemn.
Natica clausa, Brod. & Sow.
" pusila, Say.
(= N. Grœnlandica, Chemn.)
Admete viridula, Fabr.
Trichotropis borealis, Brod. & Sow.

---

Tectura testudinalis, Mull.
Lepeta cæca, Mull.

from the Gulf of the St. Lawrence, are not only typical boreal forms, but have been dredged by Messrs. McAndrew and Barrett on the coasts of Norway and Finmark. The proximity of one of the cold currents of the gulf stream, and the extremely low southern limit of floating ice on this side of the Atlantic, might indeed lead us to suspect the sub-arctic nature of the marine invertebrata of the estuary of the St. Lawrence. It appears to me that the boreal or sub-arctic character of the fauna and flora of part of Canada is tolerably well established.

The animals and plants of Canada, geographically speaking, have yet other affinities. What has been termed by Mr.

Woodward, the Atlantic region, includes the New England states, and all of the more southern states east of the Alleghanies. These mountains appear to divide two well marked groups of land and fresh water-shells. Corresponding perhaps with this zoological province, is the region of Asters and Solidagos; of Prof. Schouw. The difficulty is to separate the flora of the region east of the Alleghanies from that to the westward of those mountains. For although the fresh-water shells, of Pennsylvania, for instance, have a distinct general aspect from those of the state of Ohio, yet the plants of the two states are puzzlingly alike. That is to say, if we try to instance any group of plants, (neither mountainous and probably sub-arctic species, on the one hand, or species naturalized from Europe on the other,) we shall find it very difficult to give a list of species that do not inhabit both sides of the Alleghanies. Yet such plants as Magnolia glauca, Spiræa tomentosa, Tillœa simplex, Gnaphalium decurrens, Kalmia latifolia, Azalea viscosa, with several species of Aster, Solidago, Nabalus (?), and Vaccinium, may be considered perhaps as constituting a fair example of the Atlantic flora. Prof. Schouw's region is described as being characterized by the paucity of Cruciferæ, and Umbelliferæ, by an almost total absence of true heaths, which are represented by Vaccinium, and Gaylussacia; and by the abundance of Asters and Solidagos. This province has not been well defined from a geographical point of view. On the supposition that the Atlantic region, as defined geographically by Mr. Woodward, corresponds with Prof. Schouw's botanical province, I think we may see that in its fauna and flora, part of the Canadian area has affinities with this general natural-history region.

Almost all our Lower Canadian land and fresh-water shells are found in the Atlantic states, north of Cape Hatteras. The same is the case in Upper Canada, so far as we know, with the exception of the southwestern peninsula of that province, as previously defined. It is true, that some small fresh-water bivalves, of the family Cycladidæ, have been described from the neighborhood of Lake Superior, which have not yet been found anywhere else; but these most likely came from the south shore of the lake, in the state of Michigan, and probably belong to the western natural-history region. In Lower Canada, again, many species of Solidago and Aster abound; the genus Erica appears to be wholly absent, several species of Vaccinium and a Gaylussacia (G. resinosa) appearing instead;

while the paucity of species of the large families of Umbelliferæ and Cruciferæ is quite noticeable in Lower Canada.

The line of demarcation between the Canadian part of Dr. Hooker's sub-arctic region, and the outlier, so to speak, of the Atlantic region, in Canada, cannot be accurately defined. No isothermal line will suffice, for the simple reason that since the creation of the still existing fauna and flora, such physical changes have been effected, that the isothermals during the newer tertiary period must have been constantly varying. To sum up this part of our subject,—we have, as it seems to me, in this vast province, fragments, so to speak, of three natural-history regions. Canada, on the whole, as defined on the map, has not a race of animals, or a group of plants which are so special and peculiar to it as to constitute a good natural-history province. As I have endeavoured to shew, the southwest peninsula of Upper Canada is an outlier of the western region; and the remainder of Canada is partly of a sub-arctic type, and partly, so far as its zoology and botany are concerned, has affinities with the northern Atlantic states. With one remark I shall close this part of our subject. Prof. Asa Gray has shown us that the plants of eastern North America bear a greater resemblance to those of Japan, than those inhabiting the tract of land between the Rocky Mountains and the Pacific. At a meeting of the Natural History Society of Boston, Dr. Gould exhibited a marine bivalve shell (a species of Leda) also from Japan, which he conside. identical with a living Massachusetts species. It would be interesting to the naturalist to know if the same similarity obtains between the mollusca, &c., of the two countries, as the relations of their flora would seem to warrant.

But in order to be enabled to speculate with any degree of accuracy on the rationale of the present geographical distribution of animals and plants, we must also carefully glean what little evidence we may from the geologic record. Since the creation of at least some of the animals and plants which still people Europe and North America, mighty physical changes on the earth's surface have been apparently effected, to the consideration of which, as bearing directly on my subject, I would call some attention. Dr. Dawson has carefully catalogued the drift fossils from Beauport, the neighborhood of Montreal, Green's Creek on the Ottawa, and part of Maine. To match these we want complete and accurate lists of the marine invertebrata of the Gulf of the St. Lawrence, and carefully prepared catalogues illustrative of the zoology and botany of the interior of Canada. From Mr. Bell, and from other observers we learn that many of our common fresh-water shells occur in post-pliocene beds of much higher antiquity than our lacustrine marls, while one, if not two, of our Lower Canadian land snails, is of as high an antiquity as the Upper Eocene formation. The Helix labyrinthica of Say, a little snail not uncommon in a living state in Canada, has been found fossil in the Upper Eocene limestones of Headon Hill in the Isle of Wight, and also in the Paris basin. It has been suggested too, that the Helix omphalos, of Searles Wood, another of the Headon Hill fossils, is identical with a living Canadian snail, the Helix striatella of Anthony.

The late lamented Edward Forbes has shown us the importance of studying the fossils of the newer tertiaries in connection with the distribution of living animals and plants. It appears to me to be well, in order clearly to understand our subject, briefly to epitomize, as on a former occasion, his brilliant and most profoundly philosophical generalizations. On the tops of the mountains near the lakes of Killarney, in Ireland, occur a few plants, entirely different from those of the mountains of North Wales and Scotland, but nearly agreeing with those of the Asturian mountains in the north of Spain. According to Forbes, the southern character of these few plants, and their extreme isolation, (together with collateral facts respecting the peculiar distribution of the marine invertebrata of that region) point to a period when a great mountain barrier extended across part of the Atlantic, uniting Ireland with Spain. Soon after this, arguing from similar data, he infers that another barrier of high land connected the west of France with the southwest of England, and thence with Ireland: while a little later England and France were connected by dry land towards the eastern end of the English Channel. As tending to prove this latter view, we may cite the fact, well known to European geologists, that one fresh-water and one land snail, (Bithinia marginata, and Helix incarnata) abundant as post-pliocene fossils in the valley of the Thames, are still living in France, though extinct in Great Britain. At the time of the glacial drift, what are now the summits of the Scotch and Welsh mountains, were then, Forbes argues, low islands, or members of chains of islands, extending to the area of Norway, through a glacial sea, and clothed with an Arctic vegetation, which in the gradual upheaval of those mountains, and consequent change of climate, became limited to the summits of the new formed and still existing mountains. Few botanists who have climbed the Scotch Highlands, will fail to recollect the little isolated patches of Arctic plants on the highest mountain summits, which never occur at a less altitude than from 3000 to 3500 feet above the sea level. Well do I remember standing one fine August morning on the apex of Ben Lawers, the clouds at my feet obscuring everything below, the warm sun shining in the deep blue sky above, and admiring the glorious hue of the Alpine forget-me-not (Myosotis alpestris) the two rare mountain Saxifrages, (S. nivalis and S. cernua,) and a whole array of characteristic ferns, mosses, &c. But I am digressing. After the gradual re-upheavals subsequent to this state of things, it is believed that Ireland was connected with England, and England with Germany, by vast plains, fragments of which still exist as submarine elevations of the land on the west coast of Ireland, charged with the familiar fossils of the period. Upon these lived numerous animals, some of which, as the musk ox, red deer, and horse, yet live. Others, again, as the Arctic elephant (Euelephas primigenius), the two-horned Rhinoceri (Rhinoceros tichorinus, and R. leptorhinus), cave bear (Ursa spelæa), hyæna, etc., though now extinct in Great Britain, have left behind their bones, teeth etc., as post-pliocene fossils in the gravels and clays of our English drifts. According to D'Archiac, the separation of the British Islands from France took place after the deposition of the gravels of the valley of the Somme, in which flint implements have been found. And hence it has been inferred "That the primitive people, to whom we attribute the hatchets and other worked flints of Amiens and Abbeville, might have communicated with the existing country of England by dry land, inasmuch as the separation did not take place until after the deposit of the rolled diluvial pebbles, from among which the hatchets and other objects, have been collected."

The discovery of the fossil remains of an elephant in Sicily, near Syracuse, and at Palermo, identical with the living African species (*vide* Dr. Falconer,) renders it also probable that man lived in Europe at a time when what is now the Mediterranean was a mighty fresh water river. But to come nearer home. It has been held by many of the most eminent geologists that the great depression and subsequent gradual re-upheaval of the land during the post-pliocene age, in Northern Europe and Asia, also took place in temperate north America. Sir Charles Lyell, after careful study of the drift fossils of the United States and Canada, first propounded this theory, which has since been so ably advocated by Dr. Dawson. Throughout all Canada, at any rate east of the Niagara escarpment, we find, often at considerable heights above the level of the sea, stratified deposits of sand and clay, full of marine shells etc, generally of species which still inhabit the Gulf of the St. Lawrence. These have been so carefully and ably described by Dr. Dawson, that I need here do little more than refer to his papers on this subject. It seems pretty clearly *proved* that, at the time when these deposits were formed, the whole of Lower Canada was submerged beneath the ocean, with only the very highest points of the land left high and dry.

To explain the great cold which is supposed to have obtained over temperate Europe during the post-pliocene period, it has been ably and ingeniously suggested that at the time of the general depression of the land, the isthmus of Darien, or part of it at least, was submerged and the direction of one of the great currents of the gulf stream consequently changed. Thus the warm current which now washes the Western shores of Great Britain, then, it is urged, ran up the west coast of north America; while the cold current now washing the mainland of Labrador, then flowed around the small area of Europe left unmerged. When the re-upheaval of the land took place, the isthmus of Darien would form an impassable barrier against ocean currents, and would tend to produce the present state of things. Of later years we have obtained a few more facts bearing directly on this theory. Mr. Woodward, quoting the views of Prof. C. B. Adams, states in his Manual, in 1856, that only one marine shell (Purpura patula) is common to both sides of the isthmus. But on referring to Mr. Carpenter's able report on the mollusca of the west coast of North America, (Reports of the British Association for the Advancement of Sience, 1857,) we find very different views entertained. Thus he gives a list of thirty-five species which *unquestionably* live both on the Atlantic and Pacific shores. To these he adds twenty-four species which are *probably* common to both sides, and forty-one species inhabiting the same area, which he considers "really separated but by slight differences." It is to be remarked that our knowledge on these points is so limited, that when large series have been procured, many species now separated, may be considered identical. And from later sources, we learn that some species, not included in this Report yet inhabit both oceans. (A series of marine shells collected at Mazatlan by Mr. Moores of Columbus, Ohio, was exhibited to support this view.) Further to the north it is noticeable that several shells, mostly littoral species, occur on both the Pacific and Atlantic shores. Modiola modiolus, Crenella discrepans, Trichotropis borealis, and Bela turricula, inhabit Oregon, north-eastern America, and northern Europe. Referring again to Mr. Carpenter's Report we see that sixteen species of Arctic mollusca inhabit both the Atlantic and Pacific. These are :—

| | |
|---|---|
| Rhynchonella psittacea, Gmel. | Trichotropis borealis, Brod. & Sow. |
| Mya arenaria, Linn. | Admete viridula, Fabr. |
| Machœra costata, Say. | Scalaria Grœnlandica, Chemn. |
| Tellina solidula. (T. fusca, Say.) | Natica clausa, Brod. & Sow. |
| Mactra ovalis, Gould. | Purpura lapillus, Linn. |
| Mytilus edulis, Linn. | Fusus Islandicus, Linn. |
| Anomia patelliformis, Linn. | " antiquus, Linn. |
| Margarita arctica, Leach. | Trophon clathratus, Linn. |
| " helicina, Mole. | |

The majority of these are species of considerable geographical distribution; all but two (Machœra costata and Mactra ovalis) also inhabit northern Europe. The Tellina nasuta of Conrad, from Oregon, may be a geographical variety of the Tellina proxima of the eastern coast. In like manner Turritella Eschrichtii may be Scalaria borealis, and Littorina Sitchana of Philippi (also from Oregon) may be only a variety of Littorina patula. We have seen that eleven of the Lower Canadian fresh-water shells also inhabit the west coast of North America. Yet the grand chain of the Rocky Mountains intervenes, presenting, according to the views of most naturalists, an impassable barrier to migration. How then can we account for this apparent anomaly? Admitting that during the post-pliocene period, a great, but gradual depression of the land took place on this continent, do we not begin to see our way a little more clearly? When the mountain tops alone were left uncovered by the ocean, these snails, for instance, could only remain on, or near, the dry land, and when the land re-assumed its present shape and general physical condition, the whole area would be peopled, in part, from these sources. For supposing these creatures confined by the above mentioned causes to what are now the peaks of the Rocky Mountains, it is not difficult to conceive, that on the gradual re-elevation of the land, these molluscs could extend in both an easterly and westerly direction. Whether the theory I have advanced be true, or whether it is more likely that such sluggish creatures as fresh-water snails should have travelled the entire breadth of this great continent, and have surmounted such obstacles as a mountain chain, the highest peaks of which are from 15,000 to 18,000 feet above the level of the sea, and clothed with perpetual ice and snow, I leave for naturalists to determine.

The large proportion of marine invertebrata common to the coasts of eastern North America and northern Europe has been thought to imply the existence of a pathway across the Atlantic since the creation of the existing flora and fauna. We have seen that eight at least (and probably double that number) of the inland mollusca of Canada also inhabit northern Europe. Some such theory as the one I have alluded to, would seem necessary to explain this rather peculiar geographical distribution. Dr. Hooker's theory of the south westward migration of the Scandinavian flora, and of its subsequent return under altered physical circumstances, would seem to be doubtful on geological grounds, also from the Darwinian reasoning called in to support the latter half of his hypothesis. Dr. Dawson has cited the case of two species of Solidago living on Mount Washington, one of which (S. thyrsoidea,) has a limited range in northeastern America, while the other (S. virgaurea,) has a widely extended distribution, living as far north in Arctic America as from 55° to 65°, occurring also in the Rocky Mountains, in Great Britain, Norway, and many places in temperate Europe. He suggests that the plants which extend over so large an area, may belong to the older Arctic flora, and that the other species, of very local distribution, may belong to a newer flora. (The two species cited are not perhaps the best examples that might have been chosen to support this view, as they have been considered identical by some botanists. I would suggest the two cranberries, Vaccinium oxycoccus, and V. macrocarpon, as unquestionably distinct species, illustrating the same point.) If this theory be correct, it may be that those Lower Canadian shells which have a wide geographical distribution may be members of an older fauna than that which is more especially characteristic of a limited area in northeastern America. Judging from our present knowledge of the older post-pliocene deposits of Canada, it is quite remarkable that the species found in the marine beds are almost universally of very wide distribution.

The science of archæo-geology, or in other words, the connection between geology on the one hand and archæology on the other, may receive benefit from a much more rigorous comparison between tertiary fossils and their living analogues. Archæologists tell us there are three epochs in man's history; the first, and oldest, of stone, the second of bronze, the third of iron. The discovery of flint implements in European drifts, together with the evidences afforded by the Pfahlbauten (pile-works) or lake habitations, in Switzerland, have taught us that man was contemporary with many extinct mammals, that were once thought to date back beyond the historic period.

As yet we have no definite proof that man existed prior to the deposition of the older marine deposits of the post-pliocene period, represented in this country by the Leda clay and the Saxicava sand. In the stone period we have evidence of two races of mankind, which in all probability were separated from each other by a considerable space of time. Of the primitive race who made the so-called flint hatchets, spear heads, etc., which have been collected in such numbers in the valley of the Somme, we know but little positively. Contemporary with them were Euelephas primigenius, Bison priscus, Hippopotamus major, Rhinoceros leptorhinus, and R. tichorinus (?), the cave bear—a species said by Owen to exceed in size the grizzly bear of the Rocky Mountains—and the fossil hyæna. The fresh-water shells associated with these, with one exception, are of species still living in France. The solitary exception is the well known Corbicula fluminalis, which now inhabits the Alexandrian canal.

Whether the implements of this race were made for warlike or for agricultural purposes is not positively known. But respecting the men of the second period in the stone age, the Celts, we have much fuller knowledge. So many of their settlements have been discovered in Switzerland that it would be tedious to particularize all of them. For instance, on the lake of Geneva, twenty-four such colonies have been found; on lake Neufchatel twenty-six, and on lake Bienne eleven. The dwellers in these lake habitations belonged however to the bronze epoch, as well as to the later of the two stone periods. Some of these colonies must have been large, judging from the size of the piles and the numbers of the huts. Thus in one of the settlements on lake Neufchatel, remains of 311 cabins of large size have been found, and allowing four inhabitants to each hut, we should have an aggregate of 1244 individuals. From similar data it has been calculated that in Switzerland alone, sixty-eight villages of the bronze period contained nearly 48,000 persons; and in the older or stone period the settlements discovered would accommodate nearly 32,000.

Their dwellings appear to have been circular or square huts, grouped on wooden platforms elevated a few feet above the level of and the water, supported above it by huge piles. Each cabin had a trap-door opening on to the lake, and the whole settlement communicated with dry land by means of a bridge. The huts of the pileworks were built of wood, lined with mud, and on the exterior, boughs of wood, interlacing each other. We have been enabled to trace the way they felled the trees for their piles. They would burn a circle round the bottom of a tree, chop the charred part away with their stone hatchets, then alternately burn and chop until the tree fell. We see in the stumps the mark of the fire, and the rude cuts of their stone axes. The piles of the habitations of the men of the bronze period were much more elaborate, being made with metal axes. The lake dwellings were apparently first made by the men of the later stone period, to defend themselves against formidable wild beasts; afterwards, in the bronze age, they were found to be useful in protecting the inhabitants from the incursions of hostile tribes. It has been suggested that bronze was introduced into Europe by the Phœnicians about the time of the founding of Carthage, somewhere about the year 800 before Christ The animals most formidable to the men of the stone period in Switzerland (according to Mr. Lubbock) were the brown bear, (Ursus arctos); the wolf, (Canis lupus); the marsh boar, (Scrofa palustris); the common wild boar, (Scrofa ferus); the Urus or wild bull, (Bos primigenius); and the European bison, (Bos bison). The abundance of bones of of the elk and red deer in these settlements would seem to shew how densely wooded was the surrounding country at this time. Twenty-eight species of quadrupeds, seventeen kinds of birds, three of reptiles, and ten of fishes have been found, in fragmentary condition in the pile works. At the village of Concise, on lake Neufchatel, as many as 20,000 objects have been discovered The stone implements seem to be principally axes, knives, saws, lance and arrow-heads, corn-crushers, &c. These have been elaborately described by Mr. Lubbock in the number of the Natural History Review for January, 1862,—this article is copied entire in Silliman's American Journal for September, 1862. Their arrow-heads the Celts often made out of the bones of animals which they had slain in the chase. Specimens of their food have even been obtained in the shape of unleavened cakes, and as carbonized apples and pears. It is stated that our "rude fore fathers" were sometimes so reduced by hunger that they condescended to eat foxes. Their pottery seems to have been ornamented in the rudest way with their finger-ends and their nails. The men of the bronze age in Switzerland appear to have lived as late as the early Roman period. Remains indicative of a battle-field have been found in one of the Swiss Pfahlbauten of the bronze period, in the shape of swords, pieces of chariots, and Gauliot coins. In Ireland, lake habitations have been observed, but these are probably of more recent origin, and are mentioned in early Irish history. They were mere artificial islands on lakes; but sometimes the Irish like the Swiss, built their settlements on piles running pier-like into the water. Both of these customs appear to be common to savage nations in the historic period. Thus Venezuela obtained its name, in early times, from its supposed resemblance to Venice. From Herodotus we learn that in Pœonian villages the first platform was made at the public expense, but afterwards, at every marriage (polygamy being allowed) the bridegroom was expected to add a certain number of piles to the common support.

Thus it seems that at any rate during the earlier part of the post-pliocene period, two races of mankind have appeared and disappeared from the face of the earth, and with them have disappeared some of the larger and more powerful mammals of the period. Yet the general aspect of the animal and vegetable kingdoms seems to have changed but little from that time.

Some of the leaders in comparative ethnography have indulged in speculations concerning the geological date of the creation of man, in which they assign to the human race a far higher antiquity than the post-pliocene period. Speaking of the flint-implement-making men, Mr. Lubbock observes: "Whether the drift race of men were really the aboriginal inhabitants of Europe, still remained to be ascertained. M. Rutimeyer hints that our geographical distribution indicates a still greater antiquity for the human race." One of our ablest British naturalists goes much further and thus sums up this question. "There was a lapse of prodigious ages since man had appeared on the earth, and through which the savage habits had continued without change. And, immeasurably far back as is the age of the flint implement-making men, *as far*, or *farther back still* from them must we go to trace the primitive abode of the human species. The great battle to prove the existence of man among the mammoths, like many other first battles, has turned out in the end, a mere affair of outposts; and for the real origin of man we must go immeasurably farther back from that remarkable time, into the great pliocene or miocene age. To this period succeeded another, of which we are as ignorant as of that which preceded it. For as the mammoth, Irish elk and cave bear have disappeared from the face of the earth, so did this early race vanish away, leaving their weapons, their bones and their dwellings as the only traces of their existence. Afterwards, at an enormous interval, came another race, the Celts, in many points resembling their predecessors, living in similar habitations, and unacquainted with the use of metals, but more highly civilized and possessed of more highly finished weapons, and, as the Pfahlbauten of the Swiss lakes shew, cultivating cereals, and to a certain degree, a pastoral people." Pointing in the same direction, are Prof. Muller's theories on the origin of language, and the well known speculations of the Chevalier Bunsen. With the philological argument however the naturalist has nothing to do.

In an enquiry of so much interest and consequence, it behoves us to be very cautions. Those naturalists who have read Dr. Falconer's able papers on tertiary mammals will see that, according to that careful observer, each subdivision of the tertiary period is characterized by a group of mammals special and peculiar to it. And, as a whole, we find that the higher animals have a much more limited range in time than the lower forms of life. It would seem that the higher the organism, the less likely would it be to hold its own under trying physical vicissitudes, and altered conditions of whatever kind. Thus foraminiferæ, identical with living species, occur in mesozoic strata; and, as we have seen, one at least of our Canadian land snails lived through nearly the whole of the great tertiary period. The gravels which furnished the worked flints of Amiens and Abbeville are fresh-water deposits, not older, if as old, as the post-pliocene deposits in Canada, known locally as the Leda clay and the Saxicava sand. It is much to be wished that in the accounts both of the flint-implement-making men of the valley of the Somme, and of the inhabitants of the Swiss Pfahlbauten, we had more careful lists of the larger mammals of the two periods. As to the geological date of man's appearance on the earth, as far as I can see, we have no *positive evidence* which would date man farther back, at any rate, than the older part of the post-pliocene.

Thus I have endeavoured to jot down, in rather a cursory manner, some general thoughts which a very short study of Canadian land and fresh-water shells, etc., has suggested to my own mind. It has appeared to me that in order to speculate rationally on the geographical range of the mollusca in Lower Canada, we must take into consideration all the physical changes which have occurred since these creatures were first created. In other words, we should study the post-pliocene fossils of the district in question, and institute a careful comparison between them and the recent shells of the country. Knowing the difficulty of access to scientific works in Canada, I have made a short summary of Edward Forbes's famous essay, and have shortly epitomized Mr. Lubbock's paper on the Swiss Pfahlbauten, hoping that attention drawn to the subject, may possibly result in the discovery of works of human art in our Canadian tertiary or post-tertiary deposits.

---

## NATURAL HISTORY SOCIETY OF MONTREAL.

### First Annual Conversazione.

The society having determined to hold an annual conversazione, as a literary, scientific and social reunion of its friends, a committee, consisting of Mr. Stanley Bagg, Mr. Becket, Mr. Robb, and Mr. Rose, with Mr. Leeming, the recording secretary, was appointed to make arrangements, and the meeting was accordingly held in the Society's Rooms on the evening of Tuesday, February 3rd. The following addresses were delivered on the occasion, after which the company enjoyed themselves in examining the Museum and a large collection of works of art, microscopes, etc., furnished for the occasion by friends of the Society.

Principal Dawson, in opening the proceedings of the evening, said:—I have much pleasure this evening in inaugurating a new feature in the progress of this Society—our Annual Conversazione—an occasion on which the members of this Association, with all its beasts, birds and creeping things, announce themselves "at home," and invite their friends to a scientific and intellectual feast, which we hope will continue to grow in interest in each succeeding year, and will remain as one of the permanent institutions of the society and of the city. The last occasion on which we thus entertained our friends was that of the opening of this building, an event of the utmost importance in the history of the society, and which has more than realized the most sanguine anticipations of those who promoted the removal of the Society's collections, and the erection of our new and commodious apartments. Since that time, our collections have been largely augmented; many new members have been added to our list; and our monthly meetings have been amply supplied with interesting communications, many of them marking important steps of progress in the natural history of Canada. We have now connected with this Society, as members and correspondents, nearly all the working naturalists and geologists of British America; and our proceedings, published in the *Canadian Naturalist*, have extended the reputation of the Society throughout the world, and added an immense mass of valuable facts to the natural history of this country. The seven large volumes of our *Naturalist*, and the numbers constantly appearing, now form an indispensable part of the library of every one who studies the natural history of North America. Our labours have also been appreciated at home. The circulation of the *Naturalist* in Canada, and the fact that it is self-supporting, the large attendance at our monthly meetings and public lectures, and the recognition of the Society by the government of the country, as a recipient of a portion of the sums which Canada, in emulation of the wise liberality of older countries, annually grants for scientific and literary purposes, all testify to this. We all wish, however, that the advantages which we offer were still more largely used. Our philosophy is not of that kind which shuts itself up in pedantic exclusiveness. We regard the study of nature as the common heritage of all, and desire to open up to every one, from the little child upward, its beauties and its uses. Placed as I am at the head of an educational institution in which all branches of learning are represented, it does not become me, on ordinary occasions, to magnify my own special office as a teacher of natural science, or to insist on the reasons which have induced me to prefer in my own case the study of nature to other means of improving my mental powers and rendering myself useful to my fellow men. But here, as an officer of this Society, I may be permitted, without disparagement to other kinds of useful knowledge, to state some special claims of the study of nature. And first I would say on this subject, that the study of nature is eminently fitted to develop all our higher powers. Reasoning on first principles, this is absolutely undeniable, and might be stated still more strongly. Man is the only creature on our globe fitted to comprehend nature, and in his primitive state of innocence it was his only book; and as among lower creatures, every one is specially adapted to its condition of life, so there is a special adaptation of the powers of man, created in the image of his Maker, to that system of things proceeding in all its parts from the same Almighty mind. Practical experience confirms this inference. What more fitted than natural objects to call forth the exercise of the powers of observation, what to develope a more nice power of discrimination, what to train to all the intricacies of contingent reasoning. The man who has disciplined his mind by the thorough study of any department of nature, who has gathered together and scrutinized its minute facts, who has by careful induction learned from them general truths, who has mastered, as far as our limited intellects may, the plans of the Creator in any portion of his works, has thereby aquired a mental training more godlike in its character than any that can be gained from art or human literature, because he has been following in the footsteps, not of man, but of God. Farther, natural science grasps within itself the essence of many other departments of culture. All the higher literature and more especially the literature of the sacred books and of the more ancient nations, is imbued with nature. All true art has its foundation in the higher art of creation. The principles of mathematical and physical science have some of their highest applications in the mineral, the plant and the animal; and geology presses into its service the results of almost every kind of inquiry as to material things. For this reason, while nothing can be more simple than the mere elements of the knowledge of nature, nothing can be more intricate or abstruse than its higher questions; nothing is more suited to convince a man of his own ignorance, or to prevent him from resting in a limited range of acquirement, or from remaining satisfied with the rude attempts of man to imitate the perfect beauty and adaptation of natural things. Again, the modes of investigation in natural history bear a direct relation to those modes of thought which are most necessary in the ordinary work of life. Observation, comparison, reasoning from cause to effect,—and these in relation to the means by which the Author of nature carries on his vast operations,—are the leading pursuits of the naturalist; and their effect in producing an acute, yet comprehensive style of thought, is conspicuous in the lives and works of all eminent students of nature. Nor is there anything in natural history calculated to engender pedantry or conceit. The naturalist works in the presence of mysteries of life and structure which he cannot fathom, and which, therefore, teach him humility. He is only the interpreter of that which he cannot imitate; and he is willing, in collecting his facts, to sit at the feet of any one who can inform him in respect to the thousands of ordinary phenomena open to the investigation of every person who observes. Lastly, the revelation of God in nature, like that in his word, is thrown around us in such a way that while a little child may learn much of it, the powers of the highest intellect are tasked in reaching its higher truths, and in correcting the errors in which carelessness and ignorance envelop it. These two great revelations are twin products of the Divine mind: the one the study of man in innocence; the other the safety of man fallen :—and it is true that he who loves God most, will appreciate nature most; he who knows nature best, must best understand its Author. To disparage the study of nature as inferior to any other means of culture, is to evince the littleness of a mind dwarfed by the study of man's doings and blind to those of God, or the impiety of a soul that has no wish to magnify the works which men behold, as the external manifestation of the spiritual Creator.

But I must not follow such thoughts further, and now close by earnestly inviting all who are present this evening, to unite with us in exploring the wonders that are spread everywhere around us in nature, and assuring them that in this matter a little knowledge is not a dangerous, but on the contrary, a pleasant and profitable thing; and that while in Canada, there is scope for many more workers than we now have, there is still more ample scope for all who may desire to understand and enjoy the results of their labors.

Rev. A. F. Kemp next addressed the audience. He said it afforded him great pleasure to be there. Yet he had come there unexpectedly to himself, after rather severe labours during the preceding week; but being a great lover of natural science, he could not shrink from the invitation, and from saying such words as he might be enabled to offer on a subject so deeply interesting to him. Natural science was a most interesting part of human learning: most people liked it: it had a greater charm than most other departments. Amongst children there was a great taste for natural objects. They liked to touch things, and were curious in their inquiries about them. Curiosity was the faculty which in natural science was brought to bear upon nature. Some people, as they grew old, seemed to lose this; and their inquiry as to anything new, was merely as to its utility, and whether it would pay. But those who retain the freshness and vigour of their youth have higher conceptions of the wonderful things with which they are surrounded. I have a great admiration too for what I may call the scientific method of thinking and reasoning. This method could not be satisfied without seeing, knowing, and thoroughly understanding, if possible, all about the objects of nature that lay within the compass of human apprehension. It was close and searching. It can be satisfied only with facts carefully observed and defined as the basis of its conclusions. If anything were omitted in the inquiry, the conclusions would be all wrong: the induction would fall to the ground, like a house of cards. But when it had got all the facts and their relations to one another it could then by the inductive process reach conclusions which might be regarded as reliable and certain. There was an infinite variety in the departments of natural science. Every taste could thus be gratified. Some loved entomology; but, for himself, he did not like to stick pins into butterflies and other insects. The study of animal life was certainly full of interest, but to him there always appeared to be something rather painful, if not cruel, about it. He preferred that department of natural science which had to do with what they might term, insentient life, or that of the vegetable. It was very easy to undertake, and exceedingly delightful. To its student the mighty forests were open, whose trees lifted their heads to heaven, and if he choose he could turn to the more lowly flowers of the field. Wooing them upon the river's banks, he would be repaid with unalloyed healthy pleasure. I profess to have turned my attention a little in this direction. Dr. Dawson had said, the study of natural science made men humble. Then he (Mr. Kemp) must be so, for his part was to study the humblest forms of nature, namely, marine and freshwater plants, many of which could only be observed by means of the microscope; and he would say, that he had felt true exhilaration of mind, and pure pleasure, when he had been in the field engaged in such pursuits. In that employment, he had roamed amongst the cliffs of Bermuda, and been charmed with the sight of that climate's most brilliant marine flora. "I have sometimes had amusing adventures there. One day I remember, when looking round in the hope of discovering some new species, I saw as I conceived one of the more brilliant red plants gleaming bright, at a considerable depth in the water; it moved gracefully with every motion of the waves. I feasted my eyes on its beauty, and thought if only I could secure it without injury how glad I would be. To dive so deep and bring it up was not possible for me, so I got a long branch of a neighbouring tree, and up to the knees in water, on a rock near by, I worked till at last I caught it, and with joy pulled up my prize. But what do you think it was? Why, nothing but a bit of a soldier's red coat! (Laughter.) I was very much disgusted you may be sure. But yet it was so amusing that I enjoyed "the sell" amazingly.

"I do not need to go far for the objects of my study. They are everywhere—on the damp soil, the water spout, the pool, the high-way,—in the streamlet, the river, and the ocean. Pools of stagnant water, covered with a green mantle, were no contemptible fields for investigation. They were not unhealthful, and they were filled with objects, than which few were of greater interest. When upon a large scale, they emitted carbonic acid gas, or miasma the little things which covered them fed upon that gas, and absorbed it, leaving globules of pure and healthy oxygen. Some of these plants were exceedingly complicated and curious, and, to his mind, the most beautiful in the vegetable kingdom. Mr. Kemp here exhibited drawings of *Spyrogyræ* and *Rivulariæ*, and explained the structure and growth of these minute plants, which were constantly to be found growing in stagnant pools or on the banks of streams, and were objects of great interest to naturalists. They were exceedingly prolific, and he considered their peculiar manner of propagation as a proof of the permanency of species, in opposition to the Darwinian theory. Little and lowly they were, yet on examining their structure, and studying their economy, we were led into regions of life most wonderful and mysterious exhibiting the wisdom, goodness, and power of the Creator. Whence life came we could not tell; what it was the microscope could not discover. God concealed himself amidst his works, even while he revealed his power and skill in the outward aspects which they presented. In observing even these minute forms of life one could not but feel the truth of the saying: "Canst thou by searching find out God, canst thou find out the Almighty unto perfection?" For the speaker's part, though his special study was, from choice and profession the Bible, yet he felt bound, at the same time, to unfold and read the wondrous pages of creation. He did not believe it possible for a man to be an infidel, whilst he paid scientific attention to nature. He was glad to see his audience there. The society had left its former humble rooms; and with the occupation of better ones, seemed to have improved in spirit. Let those who were not already members, become so, and begin and prosecute the study of the works of their beneficent Creator.

The CHAIRMAN then rose and thanked Mr. Kemp for his excellent address, saying, that the poet had said, there were "tongues in trees; books in the running brooks, and sermons in stones;" but Mr. Kemp had found sermons in stagnant pools.

Selections of music, from Verdi and Donizetti, were then performed by the Band. When these were over, the Chairman introduced the Rev. Dr. De Sola, who said:—

I believe that no member of the Natural History Society will regret that it was decided to hold this pleasant social meeting here, when he looks around and sees how readily and numerously the friends of the Society have come forward this evening, to show their interest in us. And I am sanguine enough to believe that all who have come to-night are friends of the Society, and wish us God-speed in our efforts to promote its objects. And I am also sanguine enough to believe as a consequence, that those days in which the Natural History Society only vegetated, and in which even this vegetative existence was scarcely known to the public, are past, for ever past, without recall. At the same time, I do not forget that though the claims of natural science are becoming better understood, still much misconception as to its ends still exists, and some branches which this institution favors, are even now regarded with suspicion, if not with positive dislike, by many worthy persons who unaccountably fancy that the cause of revealed truth may be injured by them. This is no occasion fully to examine such an objection. We can only say to such timid persons, "Become members of this Society, and judge for yourselves, what powerful support science has given revelation." With reference to this misconception, I may go further and say that had carpers at holy writ been better naturalists, and possessed greater knowledge of physical science, they had not advanced half the fallacies they have. Thus, if the writer of a recent most crude and unfortunate publication, entitled "A critical examination of the Pentateuch and Book of Joshua,"—called critical, perhaps, because there is no evidence of fair criticism in it, on the same principle that a worthy son of Erin called himself rich, because his money could not be counted,—if this writer, I say, had only been a working member of the Natural History Society of Montreal, I am sure that at least some of his objections would not have been started, but he would have recoiled at their absurdity. As an example, when he puzzles himself with one of his favorite arithmetical propositions,—"If 600,000 men in London require so much fuel, how much did 600,000 Israelites require in the desert, where trees are few," a member might remind him that the *genus homo* amidst the fogs, damp and cold of London, requires a little more caloric than the *genus homo* travelling under the burning sun of Arabia—that to cook the bread and beef of old England requires a little more fuel than did the manna, the food of the Israelites, which was melted by the mere heat of the sun. We could also whisper to him a few secrets about animal fuel, such as the Arab even now prepares in the desert, and the prophet Ezekiel refers to. We might say something too of the changes taking place on the face of the physical world,—of Lebanon, now barren and once covered with trees—of the present sterility of parts of Palestine, formerly most productive and prosperous, and show that even the wood-fuel they had was not absolutely required; nay, we might give him a rule-of-three sum in return, and say, if 600,000 persons required so much fuel in Arabia, and so much in London, how is it that the same number of persons in these northern regions of Canada, can find cord-wood enough for their supply, when so vast a proportion of these are needy persons, and have not wherewith to supply their wants from day to day? We will volunteer the reply also. The reply is one which all the researches of this Society into the Eternal's works of the natural order, as well as the holy book gives us, and it is that the hand of God never waxeth short, but every thing, and every one, bears incontrovertible testimony to the infinite power, wisdom and benevolence of the Creator of nature. I trust my reference may be excused. But I desired to employ this opportunity to state my humble opinion that if biblical students and religionists will not avail themselves of the advantages conferred by the study of natural science, there is a certain personage who well knows how to use them, as he has ever used them, for the attainment of his own ends. And I desired to illustrate the needlessness of the alarm of some timid ones, and to demonstrate the truth that science is the true friend and supporter of religion, and that therefore, this and kindred institutions should enjoy the unbounded confidence of the community.

In inviting an accession of numbers to our ranks, we think that this Society, as pioneer in the development of natural history in this country, as originator of the present Geological Survey of Canada—for this Natural History Society was certainly first to move here—we believe it has some claims on every Canadian. A certain amount of progress has followed on its efforts, an accession of scientific talent has been made; and when I mention the name of a Dawson, a Logan, a Hunt, and a Billings, I think you will conclude with me that we number among us those of whom any Society even in Europe might be proud. We know that in a young community like ours, where nearly all are engaged in those pursuits which leave little time for scientific researches, we need not hope for a very large number able to take an active part in the primary objects of this Society. But this will not always be the state of things, and we should therefore do something for posterity. We can at least lay up materials for instruction, ready for use when they shall be wanted; and if we only do this, we shall be doing an important work, for which coming generations will thank us. But we are in fact doing more than this. The efforts of the members as they are becoming progressively greater, are also becoming better appreciated. The Society is becoming so favorably known that we may hope to see it yet bearing the same relation to all the British American Provinces as the British Museum bears to the mother country. We therefore ask all who can, to come and aid us in realizing our aspirations, which are chiefly those of the original founders of the Society—that of extending the knowledge of Natural History in particular, and of the physical sciences in general around us, so that our labors may redound to the credit not only of this growing city, but of this colony; and above all, that these labors may be additional testimony to the truth that "the hand that made us is Divine," even the hand of Him whose power, wisdom and benevolence are clearly revealed to us in all that is around.

ORDINARY MEETING, Oct. 24, 1862.

After routine business the following communications were then read and discussed:—

1. A letter from Prof. Hall on the limits of the Catskill Group of New York, showing that a large proportion of the area, more especially in Delaware county, hitherto supposed to be occupied by the Catskill Group, really consists of rocks of the Portage and Chemung Groups.

2. A letter from Dr. Van Courtlandt, on the occurrence of *Gasterosteous gymnetes*, and of a supposed New *Leuciscus* in a lake tributary to the Ottawa.

3. A paper by C. Robb, Esq., C.E., on the distribution of the Superficial Deposits in C.W., and on some phenomena connected with the Mineral Springs of that region; more especially on the fresh-water drift of Upper Canada, and on the local subsidences and peculiar deposits on organic matters produced by some of the Springs.

4. Rev. A. F. Kemp made some remarks on the proposed use of the *Zostera marina* as a substitute for cotton, and on the occurrence of this plant in Eastern America.

Several papers we announced for next and subsequent meetings; and recommendations of the Council in relation to the better arrangement and labelling of certain departments of the collection, were reported by the Secretary, Mr. Leeming, and adopted.

A number of new members were proposed, and the meeting adjourned.

ORDINARY MEETING, Nov, 24, 1862.

Principal Dawson, vice-President in the chair.

L. H. Parkes, Esq., of Birmingham, England, Microscopist, was unanimously elected a corresponding member; and Col. Dunlop, R.A., Messrs. J. E. Pell, J. S. Millar, Alex. Cowan, and H. G. Vennor were elected ordinary members.

After the general business, the following papers were read;

1. On the habits of the pine-boring Beetles of the genus *Monohammus*; by E. Billings, Esq.. F.G.S.—After some general remarks on the commercial value of our timber trees, and on the numerous insects which attack them, the author noticed the species of *Monohammus* known in North America, and gave a particular account of the habits of *M. Confusor*, with especial refe-

rence to its ravages on the timber of the white and yellow pine; and mentioned some very remarkable illustrations of the number of the insects, and the rapidity with which timber is destroyed by them.

2. On a New Crustacean from the Potsdam Sandstone; in a letter from Prof. Hall to Dr. Dawson—Prof. Hall referred to the paper on the footprints of Limulus recently read before the Society, and stated his belief that a new crustacean recently described by him before the Albany institute, but not yet published, answered to the conditions implied in the formation of Protichnites as illustrated by the modern Limulus.

3. On the Acton Copper Mines; by T. McFarlane, Esq.—In the absence of the author this paper was read by Mr. Robb. It contained an elaborate account of the mine and of the bed containing the ore, with its various disturbances; and entered into the probable origin of the deposit, and the modes of extracting and dressing the ores; being altogether the most complete and detailed account of this remarkable deposit which has yet appeared. The thanks of the Society were voted to Mr. McFarlane.

The following donations were presented to the Society:—

From P. McFarlane, Esq.—Specimens of minerals from the Giants' Causeway.

From James Ferrier, Junr. Esq.—A pair of *Fuligula albida*; and fishes for the aquarium.

From Mr. Gavin.—Two specimens of *Coluber sirtalis* (alive).

From Mr. Miller.—Specimens of Copper Ore from the Bruce Mine.

The Dublin Nat. Hist. Review, 6 Nos,; Proceedings of the Dublin University Zoological Association, 2 Nos; Journal of the Franklin Institute; Proceedings of the Entomological Society of Philadelphia, 6 Nos.; and several other periodicals and pamphlets were presented by the editors and publishers.

ORDINARY MEETING, Feb. 2, 1863.

Principal Dawson, the vice-President in the Chair. The following papers were read:

1. On the Land and Fresh-water Mollusca of Lower Canada, with thoughts on their connections with the Post-pliocene fossils of the St. Lawrence Valley, and on the general geograpical distribution of Animals and Plants in Canada; by J. F. Whiteaves Esq. F.G.S.

2. On the parellelism of the Quebec group with the Lower Llandeilo of England and Australia; and on some new or little known species of Palœozoic Fossils. By E. Billings, Esq. F.G.S.

3. On the gold deposits of Canada and the manner of working them. By Dr. T. Sterry Hunt, F.R.S.

The following donations were received:

From L. Thomson, Esq.—Specimen of the Trumpeter Swan.

From G. Barnston, Esq.—Specimens of Fishes and Reptiles.

From Mr. E. C. David—Specimen of Wild Rice from the Prairies.

From B. Gibb, Esq.—Horn of African Rhinoceros.

From Mr. J. O'Brien—Specimen of the great horned Owl.

From Mr. Hunter—Thirty-two specimens of the sternum or breast-bone of Canadian birds.

From S. Bagg, Esq.—Bye-laws of the Numismatic Society of Montreal, and a paper read before the Society.

From T. Roy, Esq.—Pictorial description of the *Victoria regina.*

From J. Ferrier jun., Esq.—Japanese work on fishes, with coloured drawings.

From Various Societies, &c.—Proceedings and publications.

---

## BOTANICAL SOCIETY OF CANADA.

The first meeting of the third session was held in the University Hall, Kingston, on Monday evening, 26th January, Prof. J. R. Dickson, M.D., Vice-President, in the chair.

The Society then proceeded to the election of office-bearers for the ensuing year, when the following were elected :—

PATRON—His Excellency Viscount Monck, Governor General.

PRESIDENT—Very Rev. Principal Leitch, D.D.

VICE-PRESIDENTS—Prof. Litchfield, M.D.; Thos. Briggs, Jr., Esq.; Prof. Dickson, M.D.; Rev. Prof. Williamson, LL.D.

COUNCIL—John Carruthers, Esq.; Rev. W. Bleasdell, A.M., Rector of Trenton; Professor Kennedy, M.D.; B. Billings, Jr., Esq., Prescott; Prof. Fowler, M.D.; M. Flanagan, Esq., City Clerk; Mr. J. Macoun, Belleville; Prof. Hincks, F.L.S., Toronto; Prof. H. Yates, M.D.; Hon. W. Sheppard, D.C.L., Drummondville, L.C.; W. Ferguson, Esq.; J. Duff, Esq.; M. Sullivan, M.D.; Rev. H. Mulkins; Professor Octavius Yates, M.D.; Prof. Lavell, M.D.; Judge Logie, Hamilton; Augustus Thibodo, Esq.; Rev.

Prof. Weir, A.M.; John Watkins, Esq.; J. Creighton, Esq., Mayor; Rev. Prof. Mowat, M.A.

SECRETARY—Professor Lawson, LL.D.
AUDITOR—Andrew Drummond, Esq.
TREASURER—Professor Murray.
LIBRARIAN—Mr. R. V. Rogers, B.A.

HERBARIUM COMMITTEE—Mr. A. T. Drummond, B.A.; Mr. W. B. Ferguson, Jr., B.A.; Mr. John Bell, B.A.; Mr. Robt. Jardine, B.A.; Mr. John McMorine; Mr. James B. Ferguson, B.A.; Mr. Josiah Jones Bell.

Professor Lawson stated that through the kindness of Professor Caruel, formerly of Florence, now at Pisa, an ample supply had been obtained of living cocoons of the new Chinese silk moth, *Saturnia Cynthia*, which yields the Ailanthine silk, now so successfully raised in France and Italy. The eggs, which may be obtained from the moths in May next, it is proposed to distribute to such members of the Botanical Society as may desire to aid in the experiment of rearing them in Canada. This silk worm feeds on the *Ailanthus glandulosa*, a tree that is quite hardy in Canada. Members desirous of obtaining eggs were invited to send in their names to Professor Lawson, who stated that although there had hitherto been experienced great trouble in unwinding the cocoons, the process of soaking in caustic potash which Mrs. Lawson had found to answer so well with the Canadian Cecropia cocoons, was no doubt equally applicable to the new Ailanthine silk. Professor Lawson likewise exhibited samples of cloth made in the Indian prisons from the floss of the Indian silk weed or mudar plant, a material precisely similar to the floss contained in the pods of Canadian silkweeds.

Mr. Rogers, the Librarian, presented the following donations to the Society's Library:—

1. From the Montreal Natural History Society—The Canadian Naturalist and Geologist, from February 1862, to January, 1863.

2. From the American Philosophical Society—Nos. 66 and 67 of their proceedings.

3. From the Boston Society of Natural History—Their proceedings, Vol. 8, pages 1 to 128.

4. Proceeding of the American Academy of Arts and Sciences, Boston, Vols. 1, 2, 3, 4, and 5,—from the Academy.

5. Annals of the Lyceum and Natural History of New York, Vol. 8. Nos. 10 and 12,—from the Society.

6. Treasures of the Deep or Scottish Sea-weeds,—from Mr. Hubbert, Knox's College, Toronto.

7. Observations on North American and other Lichens, by Ed. Tuckerman,—from the author.

8. Physical features of central part of British North America, by James Hector, M. D.,—from the author.

9. Alpine and Arctic plants. by Principal Dawson,—from the anthor.

10. John E. LeConte, a necrology, by Wm. Sharswood,—from the author.

11. From Robert J. Drummond,—Botanical sketches of the 24 orders of Linnæus; Sir J. Banks and the Royal Society; Linnæus and Jussieu, or the Rise and Progress of Systematic Botany; annual Report of the Natural History Society of Montreal, for 1862; Constitution and By-Laws of Natural History Society of Montreal.

12. From the Geological Survey—Descriptive Catalogue of Economic Minerals, &c., of Canada, sent to the London International Exhibition, 1862.

Donations of dried specimens were announced from Mr. John Bell, B. A., Mr. Josiah J. Bell, Mr. C. I. Cameron, Mr. John Macoun, Mr. John K. McMorine, Mr. Donald Ross, M. A.

The following communications were read:

1. On plants collected in Canada, by Philip W. Maclagan, M. D; Berwick upon Tweed.

Referring to the recent establishment of the Botanical Society, Dr. Maclagan observed:—Entertaining, as I always must do, a warm affection for Canada, and my many kind friends there, I was delighted to see that Botany was taking its right place among them. I wish that there had been any movement in this direction during my residence, for I often had to regret the want of some companion to share the pleasure of botanical researches. Pondering in what way I could best show my sense of the compliment paid to me by your Society, I resolved to send you a complete list of the plants I had myself collected, and of which I have specimens, during a residence in Canada extending over twelve years, in the course of which I had been stationed in various parts of the country.

Dr. Maclagan's detailed observations, which were contained in two M.S. volumes, and embraced original information respecting nearly 900 species of Canadian plants will be published in the

Society's annals. A cordial vote of thanks was accorded to the author.

2. On the Physical Character of the East Riding of Northumberland, with a list of the plants of Mr. John Macoun, Belleville. Read by the Rev. Prof. Mowat, M. A.

This was likewise a very valuable paper and will appear in the Annals. Mr. Macoun's list embraced about 800 species. The account of the physical character of the country, and the indications of its former condition, shown by ancient lake-terraces, &c., excited much interest, and the Society's thanks were voted to Mr. Macoun.

3. Account of an Exploration of Gaspé during the past summer, by John Bell, B.A.

Mr. Bell, as one of a party of the Geological Survey, spent the summer in exploring the wild spruce woods of Gaspé, and gave a very interesting account of the vegetation. Mr. Bell has added greatly to our knowledge of Gaspé plants, and obtained some species that had not previously been observed. The Society accorded him warm thanks. Mr. Bell is preparing a complete list of his collections, which were very extensive, and the list will be printed in the Society's Annals.

4. On Ailanthine, the silk yielded by the *Saturnia*, or *Bombyx Cynthia*, with remarks on the *Ailanthus glandulosa*, or false Varnish Tree, of China, upon which the Worm feeds, by Robt. Patterson, M.D., Read by the Rev. Prof. Murray.

In illustration of this elaborate and valuable paper which will be published, the author sent a very interesting series of specimens, which were exhibited to the meeting, showing the eggs, the larvæ in various stages, the cocoon, and the perfect moths, male and female. The Society's best thanks were voted to Dr. Paterson for his communication.

5. List of plants collected in Ramsay and adjoining localities, during 1861-62, by John K. McMorine.

6. List of plants collected chiefly at Fort Garry, Red River Settlement, by John C. Schultze, M.D.

7. List of Plants of Beckwith and Ramsay, C.W., by Josiah Jones Bell.

8. List of Plants collected at Wellington, during the summer of 1862, by John A. Kemp, M.D.

The above lists were laid on the table and authorized to be printed. The reading of several papers was delayed till next meeting, to be held on the evening of Friday, 13th of February.

The second meeting of the third session, was held on Friday evening, 13th Feby., the Very Rev. Principal Leitch, D.D., President, in the chair. There was a full attendance of members.

Professor Lawson, the secretary, called attention to the proposal of the Home Government, to publish under the direction of Sir William Hooker, the Queen's Botanist, Floras of the colonies of the British Empire, and a communication was read from Judge Logie of Hamilton, on the subject. Application having been made by the Colonial Secretary for the approval and concurrence of the Canadian Government, with a view to the early publication of the Canadian Flora, several of the members expressed strongly their opinion of the importance of the scheme, both in a scientific and commercial point of view, and as affording a most effectual means of making known to Canadians, as well as to the inhabitants of European countries, the nature of the products of our rich Canadian forests, which would stimulate to new branches of industry, and to the development of commercial enterprise.

Dr. Dickson, V. P., moved the appointment of a committee to bring before the Legislature, by petition and otherwise, the importance of Sir William Hooker's proposed publication, and expressed a belief that, if the Government declined to grant the small sum required, persons would be found in Canada ready to raise the amount, in a very short time, by private subscription. Committee: Principal Leitch, Prof. Dickson, Rev. Mr. Mulkins, A. Drummond, Esq., Judge Logie, and Professor Lawson.

The following papers were read :—

1. On the *Selandria Æthiops* and its destructive effects on Pear Trees. By the Very Rev. Principal Leitch, D D., President.

2. Additional remarks on Dr. Patterson's paper on Ailanthine, by the Very Rev. Principal Leitch, who gave a very interesting detail of the rearing of the Ailanthine Silk Worm in Dr. Paterson's garden at Leith.

3. Poem.—The Pines. By Charles Mair, Lanark, C. W. Read by Joshua Fraser, B. A.

4. A chapter on Fungi. By James Hubbert, Knox's College, Toronto.

The Society then adjourned until Friday, March 13.