THE TACONIC OF GEORGIA AND THE REPORT ON THE GEOLOGY OF VERMONT.

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(From the MEMOIRS OF THE BOSTON SOCIETY OF NATURAL HISTORY, Vol. IV. Issued March, 1888.)

(Read May 4, 1887.)

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I. Introduction.

THE geology of the eastern region of Lake Champlain and of the whole band of country extending from Albany and Poughkeepsie on the Hudson River, varying in breadth from ten to forty miles eastward and extending north to Quebec, Trois Pistoles and Cape Gaspé, is, by far, the most difficult and complicated that I have met with during my forty years' researches in both hemispheres. Nothing, even in the central Alps, is so puzzling and intricate.

The slates predominate as a general fact, but there are enclosed among them lenticular masses of ordinary limestone, marble, magnesian limestone, calcareous sandstone and pure sandstone, varying in size from that of the fist to small islands or even mountains 2000 feet long and 1000 feet broad. At first sight the slates are too uniform to permit of establishing stratigraphic divisions and easily recognized groups; and the lenticular masses of limestone and sandstone appear so suddenly from place to place, with such capricious distribution, that instead of being a help in the classification, they are, on the contrary, a constant cause of error and considerably increase the difficulties.

The sections are rarely very clear, and require more than ordinary caution in their surveys and interpretations. Paleontology must be used with a large margin for anomalies. Singular apparitions of forms, which otherwise are trusted as sure indications of certain groups of strata, are very likely to mislead, if not taken carefully with all the surrounding circumstances attending their position in the rocks. It is more difficult to arrive at the truth about fossils from some parts of the Taconic system than from any other system of rocks in the scale of geological formations. Even the colonies of Bohemia, first discovered and described by Barrande, in the second fauna (Cambrian) of fossils of the third fauna (Silurian), seem easier to work out and to accept. We must be contented

at first to study very minutely and patiently every square yard, stratigraphically as well as paleontologically and lithologically, at all the localities or special points presenting puzzles or anomalies; and, if the results are not entirely and fully satisfactory, we must not be too hasty in giving an explanation and in synchronizing with groups of strata regarded as typical. Nothing is so easy as to explain by faults, foldings, transverse upthrow, dislocations, overturns, overlaps, troughs, etc., but the true difficulties remain untouched notwithstanding, and we are obliged to return later to the slow process of patiently repeated observations, on the spot, turning and re-turning every fact, neglecting nothing and trying to explain rationally all that do not agree with the too hasty conclusions first arrived at.

However, as in all sciences, one good and original observer is able to combat all others, and, after all, the efforts of combined and very strong opposition only temporarily prevent the truth from being accepted. Their triumph is of short duration even if it extend through forty years and more, as is the case with the Taconic system.

Dr. Emmons discovered in 1838 the oldest series of sediment, which he described in 1842 as a special system independent of all others.[1] At first no fossils were discovered, but two years later, fossils peculiar to it were found, and the "Taconic system" was finally proposed as forming the base or first step of the column of formations, in which geologists have divided the stratigraphical history of the earth.

From that moment, the most active members of the "Association of American Geologists" took upon themselves to oppose by all means the acceptance of the Taconic system. This united opposition very soon became personal, and notwithstanding the death of some of their contemporaries, Dr. Emmons included, it has remained such, being transferred to Mr. Marcou, as soon as Dr. Emmons disappeared from the field, at the end of 1860.

As a rule all the observations and publications of Emmons and Marcou have been ostracized and regarded as *a priori* false and unacceptable. On the contrary, all that is said by the opposite party is received with consideration and even "with great pleasure."[2]

[1] Previous to Emmons' researches and classifications, several essays, all more or less exclusively mineralogical, have referred the rocks of the Taconic region to what was then considered as the "geological nomenclature for North America." Maclure, Cleaveland, Dewey, Eaton, E. Hitchcock and a few others collected facts and specimens, and between 1809 and 1836 they published papers, geological maps and sections, giving all their views as they understood the question with their limited knowledge and the very imperfect tools they had in their possession.

Vanuxem, however, is the first who referred the rocks of New York as *Transition* in his memoir, "On the classification and characters of American rock formation" (*Amer. Journ. Sc.*, 1829, XVI, 254); and it is only from that discovery of the exact and true age of the great formations of New York that anything worth recording as classification and nomenclature can be quoted.

Eaton's and Dewey's views are only mere expedients, showing their good will, even their enthusiasm, as collectors of specimens and as teachers, but that is all; and to try at this late hour to claim for them any share in the classification of the older paleozoic rocks is not justifiable and merely serves to diminish the rightful credit due to the discoveries of Vanuxem and Emmons. For more details concerning Maclure's, Dewey's and Eaton's views, see my paper, "American geological classification and nomenclature," which will soon be published.

[2] See *Quart. Journ. Geol. Soc. London*, 1882, XXXVIII, 408, in the "Discussion" at the end of Mr. J. D. Dana's paper, "On the geological age of the Taconic system."

Mr. J. D. Dana in a "Note on the age of the Green Mountains" (*Amer. Journ. Sc.*, 1880, 3d ser., XIX, 191) says: "in conclusion, the *western* half of the region between the Connecticut River valley and the Hudson River, that is, the western half of the Green Mountains area, is proved to consist of rocks that are (1) of Lower Silurian age, etc." By Lower Silurian he means the Champlain Division.

From 1872 to 1886, Mr. J. D. Dana published a dozen papers on the "Geological age of the Taconic system" (See *Amer. Journ. Sc.*, 3d series, 1872–73, 1877, 1879–82, etc., and *Quart. Journ. Geol. Soc. London*, Aug., 1882); always insisting that the Taconic schists, the quartzite and limestone, are of the age of the Hudson River group, the Trenton limestone and Chazy, and denying the existence of the Taconic system.

All this shows how hard the struggle has been. After Dr. Emmons, who bravely sustained the opposition almost single-handed during eighteen years, had disappeared forever, I came to the rescue and for twenty-seven years I have struggled, almost alone, in the same cause. How far I have succeeded, it is not for me to say. Having carried so long the whole burden on my shoulders, I know only too well how heavy it has been, and that my adversaries were not always very fair in their opposition. However, the time seems to have arrived for more just and less passionate discussion, and more steady progress is now at hand.

The United States Geological Survey has a splendid field of operation. It has already begun in earnest, and, after some unavoidable wavering in handling such a difficult question and as a first result, not only has it recognized the existence of the Taconic system, but the geologist who has charge of the work accepts already two-thirds of the strata described by Emmons — that is to say, eighteen thousand feet of strata containing a part of the primordial fauna—as certainly Taconic. One-third, about five or eight thousand feet, "the black slates, Stockbridge marble and sparry limestone," remains as debatable ground.

From my own researches in the Lake Champlain region and around Quebec city, I have not the smallest doubt as to the propriety of including also those stratified rocks as the upper part of the Taconic system and below the Potsdam sandstone. It is now a question of time, and in a few years the whole original Taconic system, as proposed by Dr. Emmons, will be accepted and regarded as the most precious jewel in the crown of American geology.

We have now to wait for minute surveys of the region embraced between central New York, Quebec, the Green Mountains, the Taconic range and the Hudson River. With all the resources of practical stratigraphy, paleontology, lithology, good topographical maps, detailed sections, geological maps surveyed with great care and exactness, the U. S. Geological Survey will complete a most important work, for it will be the base absolutely necessary for the geology of all the eastern, northern, southern and central part of North America; and, as a pioneer, who during many years of hard and solitary toil has seen the difficulties and has never despaired of the Taconic cause, I salute with joy the arrival of new observers, better fitted out and armed than I was, sure that now the truth will not be kept much longer in the background.

II. Sections around Parker quarry at Georgia. The Lorraine shales *versus* the Hudson River group. The suppressed Emmons' agricultural and geological map of the State of New York. Colony.

In 1880, I published a *résumé* of my researches around the northern part of Lake Champlain, under the title: "Sur les colonies dans les roches Taconiques des bords du lac Champlain" (*Bulletin Soc. Géol. France*, 3e sér., IX, 18), with a detailed geological map, covering the classical ground of Chazy, Isle La Motte, Georgia, Swanton, Highgate and Phillipsburgh, and several sections in the text and on one plate.

My observations were made at intervals between 1849, 1861 and 1874; and I know that several portions of the country comprised in my map needed a careful revision in the field. But travels and very grave illness prevented me from finishing the work, as

I had intended. However, I concluded to publish my observations as they were, in order not to lose them, notwithstanding my absence from Cambridge—I was then at Salins (Jura)—and the want of a reference to my specimens, and with only a part of my note-books in hand, trusting to my memory more than was prudent. So it is not surprising that I have made some mistakes, and did not give my observations as accurately as they appeared in my note-books, more especially the notes taken in 1861, which were left in Cambridge.

The important memoir of Mr. Charles D. Walcott, "Second Contribution to the studies on the Cambrian faunas of North America" (*Bulletin U. S. Geol. Surv.*, No. 30, Washington, 1886), corrects me in two instances where I have made errors, which were contrary to all of my observations made in 1861, as entered in my note-book. The errors on my part are no less true, and I thank Mr. Walcott for his corrections.

The first is a lenticular mass of calcareous sandstone enclosed in the cliff of Parker's farm, a little north of the quarry. By mistake, I have given a section on page 24 of my memoir, representing a deposit of Potsdam sandstone or red sandrock lying in a sort of depression or hollow upon the Georgia slates. Mr. Walcott has demonstrated that it is a lenticular mass containing the same fossils, *Olenellus*, *Bathynothus*, *etc.*, as the Georgia slates. He kindly refers to a letter I wrote him, December, 1885, correcting my error and giving him a copy of my section as I find it in my note book of 1861. I give it now, Plate 13, fig. 1. The lenticular sandstone is enclosed by folded slates around it except on the top. Its dimensions are: 45 feet in length and 20 or 25 feet in thickness. Several loose pieces lie at the foot of the cliff. I did not find fossils. The dip of the strata varies, according to places in this section. At the lenticular mass, the dip is only 12°; at the bending of the arch, forming the middle part of the quarry, the slates and sandstone dip 35° to the east, but at the south and in the depression towards Parker's house, the black slates dip only 10°.

The second error corrected by Mr. Walcott is more important. In my section, Plate II, fig. 1 (*Bulletin Soc. Géol. France*, 1880, IX), from Lake Champlain to Parker's house and the village of Georgia, I have considered the red sandrock, east and west, that is to say, on each side of the "Olenellus zone" of Parker's quarry, as Potsdam sandstone. Mr. Walcott has shown conclusively by direct superposition of the Georgia slates over the red sandrock, and by finding fossils, such as *Olenellus Thompsoni*, *Kutorgina*, *Obolella*, *etc.*, that at least the first three hundred feet west of the Parker quarry belong to a lenticular mass of reddish-pink dolomitic limestone and arenaceous limestone enclosed in the Georgia slates, and consequently are a part of the Georgia formation.

I must say that such was my first impression and in my field notes of 1861, I have drawn a section similar to the one given by Mr. Walcott. I cannot find in my several note books of 1862–63 and 1873 any justification for the change I made in my first section, which I now give (Plate 13, fig. 2), only I remember that at one of my last visits, a deep ditch of four or five feet had just been dug for drainage close by the eastern edge of that dolomitic limestone formation, and in such a position in regard to the dipping of the red sandrock that, if the limestone were enclosed in the slates and overlaid by them, the ditch ought to have reached the red sandrock, but it did not; and, very likely, I concluded that they were Potsdam sandstone, lying in discordance of stratification over the Georgia slates. Besides I did not find any fossils.

Let me say here, that to find fossils in those lenticular masses of dolomitic limestone and sandstone, at or near Parker's quarry, was not an easy task; for this place has been searched throughout its whole area, and very carefully, by Dr. S. H. Hall, Rev. J. B. Perry, E. Billings, Colonel Jewett and myself; and to come after such observers and detect fossils where no one of us found any, is a feat of no common occurrence. Mr. Walcott has shown himself there, as he has also at several other places in the vicinity of Georgia, Swanton and Highgate, at Trenton Falls, Saratoga, the Great Cañon of the Colorado, Eureka, etc., etc., to be the ablest collector of fossils in America, and one of the first the world over. I am glad to have this occasion to state my admiration for his keenness, persistence and extraordinary ability for finding fossils. It is a rare and very precious gift.

The Lorraine shales versus the Hudson River group.—Having acknowledged the errors corrected by Mr. Walcott, I have now to offer some remarks upon points on which we disagree.

Comparing his section, pp. 15, 16 and 17 of his "Second Contribution to the studies on the Cambrian faunas of North America," with mine, there are first the slates on the shores of Lake Champlain. Mr. Walcott, in his "Georgia sections," p. 16, fig. 1, calls them *Hudson River formations* dipping 60° east. But he gives no explanations and even in his "Ideal section from the Adirondacks over the line of the Georgia section," p. 25, fig. 2, no Hudson River formation is given.

Since my first paper, published in 1861, I have carefully avoided the use of the name "Hudson River group," which has become so hopelessly involved. The confusion created by its use, with its many meanings, must be checked, and the sooner the better. Mr. S. F. Ford in 1885 ("Observations upon the great fault in the vicinity of Shodack landing," in *Amer. Journ. Sc.*, XXIX, p. 16) has also rejected the designation "Hudson River group," using instead the old synonym "Lorraine shales."

One of the first *desiderata* is a careful survey of the typical localities of the Lorraine shales at Sandy Creek, on Lake Ontario. Then the shales should be studied in all central New York as far as Utica, and the old opinion first expressed by Dr. Emmons of a union of the Utica slates and Lorraine shales, on account of the uniformity of the lithological characters throughout the rock, should be controlled. The fauna at Sandy Creek and through central New York of the "Utica and Lorraine" would require the attention and careful studies of an excellent paleontologist as well as a good stratigraphist, like Mr. Walcott. From Utica to Schenectady, the survey should be very minute; and then, as soon as the valley of the Hudson is reached near the mouth of the Mohawk, where the Lorraine shales have been crushed and strongly laminated by lateral pressure, probably it would become necessary to put aside all the slates which do not contain a full fauna — at least two-thirds or certainly a good half of the number of species of the Lorraine of central New York.[1] We should then synchronize only the portion of the

[1] "The typical rock (Lorraine shales) is displayed in the gorges of Lorraine and Rodman, and not upon the Hudson River. In the latter region the rock is crushed, and is by no means in a condition suitable to give character to a group, hence it should be referred to only as a modified condition of the Lorraine shales."

"On the Mohawk at Cohoes, the shales and sandstones in a crushed condition are tolerably well exposed. They may be traced to Schenectady and Saratoga, where they lie in a horizontal position" (*American Geology*, Vol. I, Part II, Taconic System, by E. Emmons, p. 140, Albany, 1855).

shales found in the Hudson River valley, with the "Utica and Lorraine" which actually contain the fauna of Sandy Creek, with its Acephalae (Lamellibranchiae) and its characters of the upper part of the second fauna (Cambrian) containing forms already foreshadowing the advent of the third fauna (Silurian).

Such a survey would diminish, considerably, what is still called in eastern New York the Lorraine shales (Hudson River group), and reduce them to smaller dimensions in thickness as well as in area. The old "black shales group" of Dr. Emmons will have then to be considered and carefully surveyed from Poughkeepsie to Bald Mountain (Washington County), then through Vermont to Phillipsburgh and Quebec city; that is to say, all the western part of the great band of the Taconic system, so well delineated on the supposed lost map of Emmons, which was prepared by him to accompany the first volume of the "Agriculture of New York."

A few words about that map will not be out of place here.

The suppressed Emmons' agricultural and geological map.—The geological map of the state of New York, described at pages 361 and 362 of the "Agriculture of New York, Natural History of New York, Part v, Volume i," Albany, 1846, referred to in "Mapoteca Geologica Americana," p. 59, Washington, 1884 (*Bulletin U. S. Geol. Surv.*, No. 7), "as stolen or destroyed by persons unknown, so that it was never issued with the proper volume" (see letter of Emmons to Jules Marcou, Dec. 28, 1860, published in "The Taconic system and its position in stratigraphic geology," *Proc. Amer. Acad.*, xii, 188, Cambridge, 1885), has lately and unexpectedly made its appearance at the State Library and at the New York State Museum of Natural History at Albany.

About ten years ago, and consequently about fourteen years after the death of Dr. Emmons, the state librarian, on the plea that the first issue of the map of 1842 was out of print, began to distribute it as the "Geological map of the state of New York," the first two words of the title being omitted. But this year several copies have been distributed without abbreviation. The full title is, "Agricultural and geological map of the state of New York, by Legislative authority, 1844." The abbreviation made on some of the copies distributed during the last ten years consists in the cutting off of the words "*Agricultural and,*" forming a first line added to the map of 1842. The table of colors and classification of rocks is the same, with the exception that the Taconic system, which does not appear in the tabular view with his name or any sort of notice, exists on the map in drab color, as a large band extending from the Canada boundary line to New Jersey and the Tappan sea on the Hudson River.

The map being hand-colored, some variation in the coloring must be expected. In the copy I have now under my eyes, the Calciferous and Black River and Birdseye limestones are confounded in a single color, pale blue; while, in the map of 1842, the colors are very distinct, the Calciferous being brown and the Trenton (Black River and Birdseye) sky-blue. Another difference exists, for the three colors of the Utica, Hudson River and Oneida, which were very distinct in the map of 1842, are mingled together, more or less, under a single gray-lilac color. Finally the Portage and Chemung groups, colored green-gray in 1842, are very pale yellow in the map of 1844.

The appearance of the long lost map of Dr. Emmons, I am glad to say, has been accompanied by the return to the state Museum of Natural History at Albany of "the rocks illustrating the Taconic system, all taken out by order" many years ago (letter

of Emmons to J. Marcou, Dec. 1860, on "The Taconic system," etc., *Proc. Amer. Acad.*, XII, 118, Cambridge, 1885).

The Lorraine shales.—So far as my own observations extend, I must say that I did not find the Lorraine shales either north or east of the Adirondacks, and that between the Georgia formation and the Potsdam group, we have in all that region of Lake Champlain and the vicinity of Quebec city, between five and eight thousand feet of shales, containing now and then lenticular masses of limestone, sometimes magnesian, sometimes pure, sometimes argillaceous. Fossils generally are rare, but they exist; only, instead of being found uninterruptedly on ledges of rocks extending for fifty and even hundreds of miles, as is usual, they are limited to special localities, and have a very short horizontal range. In fact, we have in those slates, sporadic apparitions of forms of the second fauna, inclosed in the supra-primordial fauna. About a dozen and even more, say twenty, of those fossils are identical and pass from the Taconic into the Champlain or true Cambrian,[1] and when found two or three together, or even six, eight and ten in the same place and locality, always rather narrowly limited, it has been the custom until now, among all the paleontologists and consequently among the geologists who follow their lead, to say: for the citadel and city of Quebec, it is Utica and Lorraine; for Pointe Lévis, Phillipsburgh, and Bedford, it is Calciferous and Chazy; for Highgate Springs, Swanton, St. Albans' Bay village, it is Trenton limestone, and even at Highgate Springs we have according to their views, Black River limestone, Utica and Hudson River (Lorraine). Farther south at Fort Cassin, it is Birdseye; at the foot of Snake Mountain, it is Trenton and Chazy; at Shoreham, it is Chazy; at Wappinger valley (Dutchess County), it is either Calciferous or Trenton; at Newburgh, it is Trenton; at Stockbridge marble quarry, it is Trenton; the sparry limestone of eastern New York is also Trenton; the so-called hydromica schists are Hudson River (Lorraine), etc., etc.

The extraordinary geographical distribution of these so-called Calciferous, Chazy, Birdseye, Black River, Trenton, Utica and Lorraine, without any regular connection and continuity, or superposition, makes it a little difficult to classify and account for these capricious outcrops; but faults of all sorts and all shapes are now called in to help. However, it is not sufficient, and new groups or *étages*—always of the Champlain system, but unhappily always also wanting at all Champlain typical localities—have been created, under the name of lower Calciferous, Quebec, Lauzun and Sillery groups (Logan); Lewis conglomerate and limestone conglomerate of the Quebec citadel hill (Selwyn).

But, notwithstanding all these more or less artificial helps, with the addition of shore, off-shore and deeper water deposits, it remains to be explained why, in such developed divisions of five to eight thousand feet thickness, we do not find the whole fauna, say two hundred and fifty species at least, of the Champlain system, so well developed close by at Utica, Sandy Creek, Trenton Falls, Chazy, Isle La Motte, Montmorency Falls, Charlebourg and Indian Lorette Falls, instead of finding only a dozen or twenty species. Why

[1] Less than eight per cent of the species of the primordial fauna passing into the second fauna is a small proportion, when compared with twenty per cent of the Devonian species passing into the carboniferous, or with the thirty per cent of the carboniferous passing into the Dyas, or with the thirty-five, fifty and even ninety per cent of identical species between the lower tertiary, the upper tertiary and the modern faunas. The uniformist rule—each species being always confined to divisions of the second, third and even fourth order of the strata—put forward by Alcide d'Orbigny and Louis Agassiz was never accepted by Deshayes and Lyell; and since the discoveries of Barrande, Linnarson, Broegger, Dupont, Keyser, Waagen, etc., such an empyric law has become totally obsolete.

also do we not find that great number, at least two hundred species of fossils (Lévis, Phillipsburgh, Fort Cassin, Wappinger valley)—having forms considerably similar to the forms of the second fauna—which do not exist in any of the Champlain typical localities of New York and Canada? Why have we, in some of those strange fossiliferous localities of the "Black slates" of Dr. Emmons, mixed with forms of the second fauna, fossils of the primordial fauna, such as *Olenellus*, *Dikellocephalus*, *Conocephalites*, *Camerella*, *etc.;* or fossils which have not yet been recognized with certainty in any typical localities as belonging to the second fauna, as for instance the genus *Bathyurus?* Why do we have recourse to explanations entirely erroneous to explain the mixture of the primordial with forms of the second fauna at Pointe Lévis? For the two faunas found there do not occur, one in the matrix and the other in bowlders, as it is stated by the director of the Geological Survey of Canada, Mr. Selwyn, but in the same lenticular mass of dolomitic limestone; the conglomerate which exists there, just behind the village of Pointe Lévis—Colline de la Croix—being absolutely bare of fossils. Why, finally, at Charlebourg (Plate 13, fig. 8) behind the church, on the Trèsplat, is the classical Trenton, with Black River limestone, found horizontally covering the "black slates" strongly dipping east-east-south, at an angle of 45°, showing a discordance of stratification absolutely inexplicable by overlapping fault, or any other mechanical process?

No! the truth is that, after the inexcusable mistake made by the state paleontologist of New York of placing the primordial fauna at the top and above the second fauna, and the complete ignorance of the existence of almost twenty-eight thousand feet of strata, we are now contending against another mistake, not so great to be sure, but no less an error.

Section from Lake Champlain to Parker's house.—Returning now to the section of Georgia, Plate 13, fig. 2, I continue to regard the black slates on the lake shore as belonging to the Phillipsburgh and Swanton groups. Then occur in discordance of stratification over the slates, dolomitic limestones, which are numbered 1, 2 and 3 in Mr. Walcott's section. He gives them a thickness of 700 feet. Their dips are not given; but, taken on his section, they are 24° east. He found only a single fossil, a rare *Hyolithellus*(?).

I did not find any fossil there, nor did I measure the thickness of the limestone. The dip I found only from 6° to 8° east; and I have marked on my section three shallow valleys separating those masses or groups of sandrocks in which I thought I saw some slates, but I am not sure of them, except the first one near the lake, where there is a brook of running water. In the two others, however, there is stagnant water, indicating the existence of marly slates beneath.

Numbers 4 and 5 of Walcott's section are reddish-pink dolomitic limestone and gray arenaceous limestone containing fossils: *Olenellus Thompsoni*, *Conocephalites Adamsi*, *Kutorgina*, *Obolella;* thickness, 290 feet; dip 12° east. This part of Mr. Walcott's work corrects my section published in 1880. I accept it entirely, and I repeat with pleasure it is a beautiful and difficult discovery and rectification.

Mr. Walcott considers all those dolomitic limestones from No. 1 to No. 5 inclusive, as a great lenticular mass of one thousand feet in thickness, belonging to the lower part of the Georgia formation. In my section I place also his numbers 4 and 5—or the last eastern knob of limestone—in the Georgia slates; and in my geological map of 1880, the

line ought to be drawn farther west, in order to embrace the first line of Potsdam sandstone in the Georgia division. Curiously enough, in my map, that knob is marked as a lenticular mass, limited, north and south of Parker's house, to about one thousand feet in length. Also on the same map, the two other Potsdam sandstone lenticular masses on the same line as Parker's house, ought to be included in the Georgia slates, as they belong to them according to Mr. Walcott's observations.

However, for the present, I am not inclined to accept the first three numbers of Walcott's section, as belonging to the Georgia group, and also I do not admit their supposed overlapping fault on the slates, near the lake shore. I shall discuss thsee points farther on, wishing to finish the description and comparison of the two sections.

The Parker's quarry forms a steep cliff, fifty feet high at the highest point. The section and description I have given in 1861 and 1880 are still the only ones and they have not been contested, except on the dip of the strata, which Mr. Walcott gives as only 12° east in his text, and in his section, p. 16, they are drawn at an angle of 35° and even 40°, agreeing then with the inclination of 35° given in my sections and memoirs.

Between Parker's quarry and the westward limestone lenticular mass, there is a small valley, quite open, less than fifty yards broad, formed by slates, on which rests a sort of lentille of blue limestone, containing two Trenton fossils (Brachiopod and Coral). The block is only one foot and a half square; it seems to have been rolled, and I have regarded it as a boulder. Mr. Walcott is of the same opinion. However, I have some doubts now as to its being a boulder; possibly it may be a colony.

Advancing eastward, above the Parker's quarry, there are slates forming a platform and then a declivity. Directly north we find the end of a lenticular mass of magnesian limestone containing Brachiopoda, about twenty feet thick, and extending from the top of the hill to the road from St. Albans' bay to Parker's farm. Their dip is 15° or 16° east. The slates in front of the limestone, on the declivity, seem to dip at 30° and 35°, but some cleavage may exist there; and it will be better to have new observations made before giving a definite dip.

Colony.—At about only twelve or twenty feet from the limestone lentille, are found several isolated slabs or flag-stone, lying on the slates, in concordance of stratification. Almost one foot thick, three or four feet in length, with sharp angles, they consist of a sort of blue limestone containing two or three fossils of the second fauna. From their position and peculiar forms, which will not admit transportation by a glacier, I regard them as surely a colony of the second fauna inclosed in the Georgia slates. In the walls near the house of Mr. Parker, some loose pieces of blue limestone, containing one or two Trenton fossils, have been seen. It is impossible to say whether they come from a boulder or from a colony near by. I have no doubt that other colonies will be found among the Georgia slates, not only in the Lake Champlain region and in Canada, but also all along in southern Vermont, in eastern New York, and in western Massachusetts.

My section fig. 2 ends a little northeast of Parker's house. I do not see any change to introduce in my former section of 1880, eastward from Parker's to the Green Mountains. Mr. Walcott has found a fault between Georgia Village or Centre and the Vermont Central railroad, and has stopped short with a blank at the foot of the first Green Mountain hill.

In the lenticular mass of limestone, marked on my geological map, between Parker's farm and Georgia Centre, Mr. Walcott has been successful in finding a few fossils: *Lingula*, *Orthisina*, *Camerella*, *Agnostus* and *Conocephalites*, which he thinks indicates perhaps the Potsdam formation. I regard those determinations of Potsdam and fault as merely conjectural, and I am convinced that the more eastward we go, after leaving Parker's farm, the older are the strata.

III. Age of the Red Sandrock, and section near Swanton.

The discordance of stratification on the western edge of the red sandrock is so well marked everywhere, and Billings was so positive as to the paleontological age, that I did not hesitate to refer the whole series to the Potsdam sandstone formation. I confess that I ought to have been more careful and more prudent with some parts of them; for I have seen at Swanton red and yellowish calciferous sandrock inclosed in the Georgia slates, and on the road from St. Albans' Bay to Parker's farm I have crossed several ledges of red sandrocks with Georgia slates intercalated in concordance of stratification. But I had so many other questions to attend to, and always thinking that I had full time to make a complete survey, that I passed it over without proper attention.

The discovery of Mr. Walcott, of the Georgia slates fauna, in some parts of the red sandrock, not only at Parker's farm, but also at Highgate Spring near Church's farm, shows that I have made a mistake. But are all the red sandrocks of Vermont a part of the Georgia slates, as Mr. Walcott seems to consider them, or some portion of them only?

The absence of a geological map from Mr. Walcott's paper leaves us in doubt as to many of his opinions; perhaps if he had tried to put his observations on a detailed map, he would have found difficulties which would have made him hesitate about some of the views presented in his memoir.

Lithologically there is a great similarity between the red sandrock of Vermont[1] and the typical localities of the Potsdam formation at Potsdam, at Keeseville, as well as in Beauharnais county (Canada). Magnesian limestone interstratified with pure sandstone or sometimes calcareous sandstone, of gray, red and pinkish colors, form the two groups, as well in Vermont as in New York and Canada. The occurrence of similar sequences of beds of the same lithological characters, and so near one another as Keeseville and Georgia, are certainly puzzling and may mislead, if not properly checked by paleontological and stratigraphical facts.

Paleontologically, the finding of *Conocephalites Adamsi* in Vermont, so nearly related to *Conocephalites minuta* of Keeseville, was in favor of identification of the two formations. But there is more. I have collected in the section of Swanton, on the ground of Doctor Hall's farm (now Bullard's farm) in the pinkish-red sandrock, an imperfect glabella of *Conocephalites minuta;* and Mr. Walcott signalizes a *Lingula*[2] in

[1] The red sandrock of Vermont is generally formed of a limestone containing a little sandy matter, and is almost always magnesian or dolomitic. It has often a globular structure, which gives to some of the beds the form of a pudding or even of a breccia; and the marble manufacturers of Swanton have taken advantage of the varieties of colors given by that structure to work largely for the trade several strata in the vicinity of Swanton and St. Albans.

[2] "Second contribution to the Cambrian faunas of North America," p. 19.

a limestone conglomerate or breccia, and *Lingulella* in the shales at the same place. My specimen of the head of *Conocephalites minuta* was determined as such, in 1881, by Mr. Whitfield, and is at the American Museum of Natural History at New York. I did not pay any attention, at the time of finding it (in 1862), as to what part of the section it belonged; but it came from that place without a possible doubt.

We must say that the *Conocephalites Adamsi*, confined, for many years, to the single locality of Church farm where it is generally found in loose pieces of very pinkish-red sandrock, has been collected by Mr. Walcott in many other places, and seems to range through at least fifteen hundred feet of magnesian limestone, slates and sandstone at Highgate Spring and at Georgia. Until now, it is certainly the primordial fossil which possesses the greatest range, carefully recorded, of all those found in the Taconic of Vermont.

Stratigraphically, the red sandrock is seen in such position at different places,—for instance, on the shore of the lake at Highgate Spring, Highgate Falls, Swanton, St. Albans' Bay and Shelburn Falls, that it left no doubt as to its being an overlying formation which, according to J. B. Perry, "in several instances, extends over almost the entire, if not over the whole, width of the Taconic series of Dr. Emmons."[1]

The existence of lenticular masses of magnesian limestone and calcareous sandstone, inclosed in the Georgia slates, is certain from the observations of Mr. Walcott at Parker's quarry and at Highgate Spring (Church and E. Stearns's farms). I shall add my observations at Swanton, on the ground of Dr. Hall's farm, where I saw in 1862 the following section; Plate 13, fig. 3. It began at the Missisquoi river, running east-east-south, passing first at the small Sugar cabin and then over the two lenticular masses of blue and gray limestone.

1. Sandy alluvial; 15 feet.

2. Red sandrock, massive, passing to a red magnesian conglomerate; almost horizontal, the dip being only 1° or 2° east. No fossils; 30 feet.

3. From the Sugar cabin to the summit of the first hill an alternance of Georgia slates with beds of gray, reddish and yellowish calcareous sandstone; about 200 feet. Dip 12° to 15° east. Fossils: *Olenellus Thompsoni*, *Camerella antiquata*, *Conocephalites*, *etc.*

4. A first lenticular mass of a very hard blue limestone, brecciated, of only thirty feet of diameter, containing a great quantity of fossils, more especially *Obolella* (*Kutorgina*) *cingulata*, *Orthisina*, *Camerella* and *Conocephalites*.

5. A little southeast, separated from No. 4 by black slates containing *Olenellus Thompsoni*, *Conocephalites Teucer*, *etc.*, there is a second lenticular mass of another very hard limestone, whitish-gray, with veins of carbonate of magnesia; containing also numerous fossils: *Olenellus Thompsoni*, *Conocephalites Teucer*, *Kutorgina cingulata*, *etc.* The part that crops out is larger than at the first lentille and shows a diameter of fifty feet.

6. Black slates with some beds of sandstone containing *Palaeophycus*. The slates are cleaved and in some places I have seen a difference of 35° between the cleavage and the stratification. The largest specimen of *Olenellus Thompsoni* I have ever seen was found there and it shows finely the cleavage; it can be seen at the American Museum of Natural History of New York, to which I have given some of my best specimens.

[1] "Queries on the Red Sandstone of Vermont, etc.," p. 6, Boston, 1868.

7. Red sandrock forming the top of the hill. I did not make any observations on that part of the section, nor farther east, where are seen other slates and red sandrock hills.

I have referred the red sandrock near the Missisquoi river, No. 2, as belonging to the Potsdam, and I see nothing in what has been published by Mr. Walcott to change my view. As to the other expositions of red sandrock, marked No. 7, and farther east, I cannot give any decided opinions; they need to be carefully examined before any conclusion can be reached. Perry says "In some cases, the Black or Swanton Slate (comprising also the Phillipsburgh group) may be seen beneath the Potsdam sandstone (red sandrock), not only along its western flank, but also at the very edge of its eastern limits. After long searching, I was at last so fortunate as to find the two rocks thus situated and in immediate conjunction. This was on the easterly border of the sandstone, at Shelburn Falls, where, some years ago (in the summer of 1860) an excavation was made in the channel of the La Plot river. Since that time, I have observed substantially the same thing at many other points. So the Georgia Slate may be traced beneath the Potsdam sandstone (red sandrock) with equal clearness and shown to underlie it, in its extreme extension eastward in Swanton."[1]

There is no reasonable doubt that some portions of the red sandrock are younger than the Georgia slates or formations and belong to the Potsdam sandstone. But the opinion expressed by Mr. Walcott has also incontestably some basis, and the question must be met by a new and very careful survey.

My opinion is that two-thirds of what is generally called red sandrock belongs to the Potsdam formation, and that one-third only is a part of the Georgia formation. I am inclined to believe that those two different ages of red sandrock are in juxtaposition on some part of the line of the outcrop of the Georgia formation. I think that a difference in the dip of the two series is well marked by an angle of 10° or even 14°. On the western side of the red sandrock line, the dip is very small, the strata being almost horizontal, or varying from 1° or 2° to 6° or 8° at most; when, on the contrary, the red sandrock, clearly belonging to lenticular masses inclosed in the Georgia slates, has an eastern dip of 12° to 16°.

IV. The supposed overlying great fault of the Georgia formation.—The section at Charlebourg near Quebec.—Landslides at Montmorency and Indian Lorette Falls.

I have previously said that Mr. Walcott regards the discordance of stratification on the western limit of the red sandrock as due to an overlapping fault of the Georgia formation, which covers what he calls the Hudson river group, Trenton or Chazy, according to localities. He thinks that the massive red sandrock was pushed over on the slates, and consequently that the slates have been crushed, strongly compressed and forced under the red sandrock.

The break and dislocations of the Taconic rocks are very great and the slates show everywhere strong lateral pressure by their cleavage and their contorted and faulted

[1] "Queries on the Red Sandstone of Vermont, etc.," pp. 10 and 11, Boston, 1868 (Ex. from *Proc. Bost. Soc. Nat. Hist.*, xi.)

structure. I have already given an example of the folding with fault of the Swanton slates, which is seen just below the bridge of Swanton Falls, the contorted slates being cut also by small local and very limited faults (see "Sur les colonies dans les roches Taconiques des bords du lac Champlain," in *Bulletin Soc. Géol. France*, IX, 29, Paris, 1880). I shall now give several other examples.

At Parker's quarry, Georgia, near the top of the section, fig. 1, just above the main range of *Olenellus Thompsoni*, in a sandy limestone with nodules of red iron, there are small contorted beds made by strong pressure, as represented by fig. 4 on Plate 13.

At Highgate Falls, in the lenticular mass of limestone, there are numerous contorted beds of brecciated limestone, as seen on Plate 13, fig. 5, in a distance of only fifteen or forty feet and with a thickness of thirty or forty feet. The most remarkable of these contorted structures is seen on the left bank of the Fall, between two houses built on high walls, fig. 6.

At Pointe Lévis, the cliffs show several folded and contorted strata containing a quantity of simple and compound graptolites. Fig. 7, on Plate 13, represents, near the railroad depot, just behind the Victoria hotel, the same folding observed farther east at the turning of the road from the ferry to the church of Notre Dame.

The section at Charlebourg near Quebec.—At Charlebourg, on the road in ascending from Charles river to the village,[1] we have in the Quebec-city and Citadel-hill slates or Swanton slates very numerous and complicated folding with small local faults. The slates are beautifully contorted; and behind the village at the Trèsplat, several quarries in the horizontal Trenton limestone have reached the slates, and I have seen them contorted and dipping 45° east-east-south under the almost horizontal Black River and Trenton limestone (see Plate 13, fig. 8).

Landslides at Montmorency and Indian Lorette Falls.—This section of the road to Charlebourg shows that there is no great fault at Montmorency Falls, at Petit Ruisseau and at Indian Lorette, but only small local landslides. Denudation and erosion of the slates have undermined the Trenton limestone above, and, little by little, the band of almost horizontal Champlain system has been excavated, destroyed and washed away, diminishing its breadth by one-half and even more in some places, only about one-third and probably less of what was originally deposited now remaining.

The process of destruction, underneath the slaty base, has forced the Trenton limestone and Utica slates cover to slide down, as it is now seen at Indian Lorette Falls, and on the right side of the chasm at Montmorency Falls, where some large fragments or blocks of Trenton limestone are seen suspended on the asperity of the quartzite. And at special places, like the ravine in V-shape, at the foot of Montmorency Falls, on the left, the Trenton and Utica, coming above a gully or truncated trough between the quartzite and the Taconic black slates, slid down, filling up a part of the chasm. It is a sort of fault by land slips, very limited, absolutely local and comparatively of recent occurrence. At the contact of the Utica and Taconic slates (Quebec Citadel Hill slates), the strati-

[1] The contorted slates are on the right side of the road, fig. 8, and also on the left. Between the two small faults and the village of Charlebourg, there are at least eight hundred feet of slates, but the section does not show that great thickness, the distance not being drawn to scale, for want of space.

fication is very confused and the dip of strata, which at the foot of the ravine is only 10 to 20° for the Trenton limestone, increases rapidly to 30° and 40° for the Utica slates, and to 60° and almost perpendicular for the Taconic slates.

Messrs. Logan and Selwyn have given sections in 1861: "Considerations relating to the Quebec group" (*Canadian Naturalist and Geologist*, May, fig. 1), and also in 1884: "Descriptive sketch of the physical geography and geology of the dominion of Canada," Montreal, fig. 1, of the Montmorency Falls extending to the Orleans island. Both consider all the strata between Montmorency and the eastern part of Orleans island as Trenton limestone, Utica and Lorraine (Hudson River), and Calciferous and Chazy (Quebec group) with two large faults. Mr. Selwyn goes so far as to find three large faults, one on each side of Orleans island. Those diagramatic sections of supposed structure are only speculative and have been used to settle the relations of strata of very doubtful age, and proved to be very embarrassing in the altered and finally adopted classification of the Canada survey.

Very small and limited local landslides, on the southern edge of the band of Trenton limestone and Utica slates, have been taken for a big fault. As soon as Logan saw that it was impossible to maintain any longer the age of the red sandrock, as Oneida conglomerate and upper Hudson River group, he had recourse at once to faults, which strangely enough he had failed totally to see during twenty years; and he did not hesitate to submit the strata in discussion to the most complicated folding, overlapping, upheaving and breaking. Fault upon fault with all sorts of disturbances was used most freely, in order to sustain his "Quebec group," instead of accepting openly the "Taconic system;" the only result was to create more confusion, of what was already confused enough.

These examples show sufficiently the enormous pressure exerted on all the Taconic rocks of Vermont and Canada, prior to the deposits of the Champlain system or true Cambrian. If there was on the western line of contact of the red sandrock with the slates and lenticular masses of limestone a great overlapping fault, as the slates, according to that view, have been forced under the magnesian limestone, they ought to have upheaved and raised more or less strongly the upper lip of the fault. The natural result would have been that, at the contact of the red sandrock, the beds would have been raised almost perpendicularly, as represented on Plate 13, fig. 9. But, on the contrary, at Georgia, fig. 1, at St. Albans' bay, at Swanton, fig. 3, at Highgate Fall, fig. 6, and at Highgate Springs, the red sandrock or magnesian limestone are considerably less raised, dipping only from 2° to 8°; when farther east, at some distance from the supposed fault, their dip is from 12° to 16°. At Swanton and at Highgate Falls, they lie almost horizontally on the slates and on the lenticular masses of magnesian limestone, and precisely at points where the most powerful forces must have acted in order to fold and contort, as they did, the beds of the Phillipsburg group. The conclusion that the red sandrock at Highgate Falls was deposited after the dislocation and break, and over the contorted strata of the Phillipsburgh group is unavoidable. The red sandrock at the fall, and on the left bank of the Missisquoi river, is of Potsdam age, lying in discordance of stratification over the Phillipsburgh group.

The tendency to explain every stratigraphical and paleontological difficulty by a fault is natural enough, but must be checked by direct observations; and all the objections

based on facts must be answered and explained otherwise than by the inference of a miraculous and invisible fault.

V. The Report on the Geology of Vermont. The Classification and Nomenclature of Messrs. E. and C. H. Hitchcock.

Until now I have refrained, in all my papers, to review or even to notice the Geological Survey of Vermont. Mr. Walcott having taken it as an authority, not only for the history of the Georgia formation, but also on questions of priority in nomenclature and paleontological publications; and Prof. C. H. Hitchcock's position lately taken in two publications in the *Bulletin of the American Museum of Natural History* of New York[1] and in the *Transactions of the American Institute of Mining Engineers*[2] render it necessary to give exact dates of publications, exact titles of reprinted papers in the "Geology of Vermont," and to quote the classification and nomenclature used for the strata of Vermont.

The "Geology of Vermont" is a work in two quarto volumes, containing the geological map of Vermont, published by the state of Vermont at Claremont, New Hampshire. Its title is "Report on the Geology of Vermont: Descriptive, theoretical, economical and scenographical," by Edward Hitchcock, Edward Hitchcock, jr., Albert D. Hager and Charles H. Hitchcock, published under the authority of the state legislature by Albert D. Hager. As Messrs. Edward Hitchcock and Charles H. Hitchcock are the only members of the Survey who treated of stratigraphy and paleontology, I shall only refer to them in my quotations and remarks.

These two volumes are three times antedated, and as they were not entered in the clerk's office of any district court for copyright, we do not possess any direct means of knowing their exact dates of publication. But we shall come to it within a few days by strict study of their contents and the time when they were distributed.

The Introductory or "Preliminary Report," as it is called, is dated Oct. 1, 1859 and directly an additional preliminary report is added with the date of Oct. 22, 1860 (see pp. 15, 16 and 17). Official reports are not always printed and issued at the date of presentation to legislative bodies, governors, or Congress; although the introduction is always written when the reports are completed and ready for the printers, and I would not have pointed out these two dates of the "Preliminary Report," if Prof. C. H. Hitchcock had not claimed priority for another work, "Outline of the Geology of the globe, and the United States in particular, etc.," Boston, 1853, based on the date of the introduction which, according to his opinion, ought to be accepted as the date of publication[3].

[1] "Geological sections across New Hampshire and Vermont," Art. VIII, Vol. I, No. 5, p. 155, Feb. 13, 1884, New York.

[2] "The geological map of the United States" (St. Louis meeting, Oct., 1886).

[3] See "The Geological Map of the United States" in *Trans. Amer. Inst. of Mining Engineers*, Oct. 1886, where at p. 7, Mr. Hitchcock says; "E. Hitchcock's map of 1853. The manuscript and maps were delivered to the publishers in January," is the only plea for the introduction being dated January 1, 1853, and placing it as anterior to "Jules Marcou's Map of 1853." As the two maps and books were both copyrighted at the same Clerk's Office of the District Court of the District of Massachusetts for 1853, at Boston, it is very easy to see the exact date of their publication. Marcou's map was issued on July 1, 1853, when Hitchcock's map only appeared in October, 1853, more than three months later (see also the advertisements of all the leading Boston newspapers for 1853).

In the "Geology of Vermont" there are reprints of four papers which were issued respectively in December, 1860, January, 1861, February, 1861 and November, 1861, showing it is an impossibility to claim the dates of the introduction (Oct. 1, 1859 and Oct. 22, 1860) as exact dates of publication of the work.

The third date found in the "Geology of Vermont" is at the bottom of the title page in the two volumes, and is 1861. It is also an antedate by several months of the true year. The first printed record I have been able to find of the publication is in the *Amer. Journ. Sc.*, May, 1862, XXXIII, 416, New Haven, where a review of the work is dated Montreal, March 18, 1862. The review was written on an advanced copy, for the work was not received in Boston until March 21, 1862. So the exact date of publication is the end of March, 1862.

Now that we have fixed within a few days the publication of the "Geology of Vermont" by Messrs. Hitchcock, let us notice some part of its contents. I shall only refer to what relates to the Taconic system and the Primordial Fauna.

First, all the papers by Barrande, Logan, Hall and Billings are simply reprints and not always correctly given. At p. 377, we have "Barrande's views" under the title: "On the Primordial Fauna and the Taconic system of Emmons, in a letter to Professor Bronn of Heidelberg" (*Proceed. Boston Soc. Nat. Hist.*, Dec., 1860, VII, 371). If we look at the volume referred to, we do not find any paper with such a title, but instead the following title "On the Primordial Fauna and the Taconic system by Joachim Barrande, with additional notes by Jules Marcou." These notes of Marcou are not given in the "Geology of Vermont," but a second letter of Barrande addressed to Marcou is added without reference to its recipient, leading one to suppose that it was addressed also to Bronn.

The paper by Billings, at p. 942 (appendix) is without the general title of the pamphlet, published November 21, 1861, at Montreal, which is "New species of Lower Silurian fossils." Besides, Mr. C. H. Hitchcock has suppressed, without any notice, a whole page of Billings' paper, a very interesting foot-note, pp. 11 and 12, containing among other information a letter from C. H. Hitchcock himself.

By these two quotations we see that the "Geology of Vermont" cannot be used as priority for the papers of Barrande and Billings, nor even as an exact reprint, being both defective in regard to titles and contents.

The classification and nomenclature of Messrs. E. and C. H. Hitchcock.—I shall now give quotations of the classification and nomenclature used by Messrs. Hitchcock.

Page 257: "List of the rocks occurring in Vermont in an ascending order.

Laurentian or hypozoic gneiss.	Hudson River group.
Potsdam sandstone.	Red sandstone series.
Calciferous sandrock.	Quartz rock.
Chazy limestone.	Georgia group.
Birdseye limestone.	Talcose conglomerate.
Black River limestone.	Eolian limestone.
Trenton limestone.	Talcoid schists.
Utica slate.	Upper Helderberg limestone."

Page 326: "Red sandrock series. Stratigraphically considered, this series of beds occupies the position of the Medina group of New York" (from Prof. William B. Rogers).

Page 339: "*Conocephalus* (at Highgate, directly east of the house of J. Church). The form known to me most nearly like this one is in the Clinton group of this state, New York (from Prof. J. Hall). With a shell resembling *Atrypa hemispherica* of the Clinton group of New York."

Page 357: "Georgia group. Upper Hudson River group: *Elementary Geology*, 31st edition, p. 411, by Ed. and C. H. Hitchcock, 1860."

Page 374: "Georgia slate. Its fossils rank it as Lower Silurian (Second Fauna) rather than Cambrian (First Fauna)." "The stratigraphical view of the Georgia slate which has been so ably defended by Professor Hall (James) seems to demand for it a place either above or equivalent to the Oneida conglomerate."

Page 375: "The natural inference from these relations is that the red sandrock is of the age of the Oneida conglomerate or Medina sandstone and the Georgia slate is still newer and therefore Middle Silurian."

Page 393: "Talcose conglomerate . . . is newer than the Georgia slate."

Pages 394 and 421: "Eolian limestone . . or Stockbridge limestone . . may be as recent as the carboniferous rocks." "In the middle of the limestone fossils which, though obscure from metamorphism, are clearly referable to genera characteristic of Devonian rocks."

Pages 424 and 433: "Talcoid schists are newer than the Eolian limestone."

Page 434: "The Taconic system." Mr. Hitchcock claims that the outline of its method and explanation represents Prof. Emmons' ideas "as faithfully as though we were the amanuensis of an advocate of the Taconic system." This "brief view of its history as a system" is full of reticence and even opposition, and is simply an *ex parte* and partial exposition, according to Hitchcock's understanding of the Taconic system.

The "Geological map of Vermont traced out and compiled by the members of the Geological Survey," 1861, scale of miles $\frac{1}{400,000}$, is placed at the end of the second volume, as Plate I.

"Explanation of the colors." In ascending order.

Granite, syenite and protogine. Gneiss. Hornblende schist. Serpentine. Talcose schist. Calciferous mica schist. Clay slate.	Azoic.	Oneida conglomerate (red sandrock.) Quartz rock. Georgia slates. Talcose conglomerate.	Upper Silurian.
Potsdam sandstone. Calciferous sandrock. Chazy, Birdseye and Black River limestones. Trenton limestone. Utica slate. Hudson River slates. Hudson River limestones.	Lower Silurian.	Eolian limestone. Talcoid schist. Beds of limestone in talcoid schist. Upper Helderberg limestone.	Mostly Devonian.
		Pliocene tertiary. Gold in alluvium, etc.	

The map had two editions. The first one, distributed in December, 1861, contains the name *Oneida Conglomerate* inscribed instead of *Red Sandrock;* and the rocks are united by great groups or systems, by means of brackets under the general names of Azoic, Lower Silurian, Upper Silurian, and mostly Devonian. In the second edition accompanying the volumes, those brackets and general names are half defaced, as well as the name Oneida conglomerate. But on almost all the copies attached to the work, the erasures have been done so imperfectly, that it is easy to read those names and to see the brackets.

VI. Historic classification and use of the name Georgia; with some paleontological remarks, and some notes on the Graptolite zones in America.

Now we can give in true chronological order the history of the Georgia formation, with the exact dates of publication.

1855.—Mr. Noah E. Parker, a farmer in West Georgia, in quarrying large slates for a floor, found some trilobites. He showed them to the schoolmaster of the village, who wrote at once to the state geologist of Vermont, the late Zadock Thompson of Burlington. Thompson came directly, visited the quarry, but died in January, 1856, without publishing anything about the discovery and the geology of Georgia. However, before his death, he placed the specimens of trilobites in the hands of Mr. James Hall, with the request to publish them. I would remark that, in 1856, the primordial fauna of Barrande had been established for ten years, and several works and pamphlets had been published on the subject in Paris, in Bohemia and in Scandinavia, not to speak of the Taconic system with a special fauna recognized at first sight by Barrande as primordial, as soon as he saw Emmons' work. Twelve years had passed away since 1844, and the paleontologist of New York entirely ignored the primordial fauna, its stratigraphical position, its meaning, and the Taconic system.

1859.—Mr. James Hall, in "Twelfth Annual Report, Regents of the University of the state of New York," page 53, Albany, 1859, calls the shales in the town of Georgia, *shales of the Hudson River group*, and at page 62, he adds that Logan places "the shales of this locality in the upper part of the Hudson River group, or forming a part of a series of strata which he is inclined to rank as a distinct group above the Hudson River proper." Then Prof. J. Hall adds "it would be quite superfluous for me to add one word in support of the opinion of the most able stratigraphical geologist of the American continent."

In the article entitled: *Trilobites of the shales of the Hudson River group*, Mr. Hall describes and figures the fossils sent to him by Zadock Thompson, under the names of *Olenus Thompsoni*, *Ol. Vermontana* and *Peltura* (*Olenus*) *holopyga*.

1860 (Mar.). "Mr. C. H. Hitchcock exhibited a geological map of Vermont and explained the principal features of the complicated geology of that state." "The two most interesting points in this connection were, that there is *no foundation for what Mr. Emmons called his Taconic system* (a mixture of the Silurian and Devonian), and that the Dorset limestone (his Stockbridge limestone) is newer than the Lower Silurian, and is probably Upper Silurian or Devonian." (See *Proceed. Boston Soc. Nat. History*, Vol. VII, pp. 236, 239, Meeting of March 7, 1860.) At the same meeting Prof. W. B. Rogers

communicated the manuscript of a paper entitled: "Notes on the geological structure of western Vermont, etc.," read by him before the American Association at Albany in 1851. In it he refers the reddish sandstone and shales, and reddish, white and gray limestone as a group "belonging to the period of the Oneida and Medina rocks, to which Mr. Hitchcock now refers them."

1860 (July). Dr. Ebenezer Emmons, in the second edition of his *Manual of Geology* New York, published during the summer of 1860, in note A, page 280, calls attention to Professor Hall's remarks, in the Regents' Reports of New York for 1860, and declares that the shales referred to in northern Vermont, instead of being a new series above the so-called Hudson River group, are really sub-silurian and of the same age as the *Paradoxides* and *Olenus* primordial zone of Bohemia. (See *Manual of Geology*, page 87.)

1860 (Oct.). "Mr. Marcou made a communication on the black slate of Braintree, Mass., containing *Paradoxides*, and on similar strata in Newfoundland, near Lake Champlain and in the vicinity of Quebec," afterwards given in detail in the paper entitled: "On the Primordial Fauna and the Taconic system, by Joachim Barrande; with additional notes by Jules Marcou." (See *Proceed. Boston Soc. Nat. History*, Vol. VII, pp. 357 and 369. Published November 23, and December 24, 1860.) On page 375, Mr. Marcou uses for the first time the name *slates of Georgia*, and refers them to the Taconic system of Emmons.

1861 (Feb.). In the "Thirteenth Annual Report Regents University, New York," dated on the title page 1860 (but the true date of publication is February, 1861), Prof. J. Hall gives a new description of the three trilobites found at Georgia under another title: "Note upon the trilobites of the shales of the Quebec group in the town of Georgia, Vermont," pp. 113 to 119. We must remark, that the "title was changed in a part of the edition, by substituting the words *Quebec group* for *Hudson River group*, in deference to the views advanced by the Geological Survey of Canada." (See "Fifteenth Annual Report Regents University, New York," page 196, Albany, 1862.)

The author describes and figures the same three trilobites under new generic names: *Barrandia* substituted for *Olenus*, and *Bathynotus* instead of *Peltura* or *Olenus*, making two mistakes. First the genus *Barrandia* existed previously for another form of trilobites, having been proposed as far back as 1849 by McCoy (see *Ann. Nat. Hist.*, 2nd series, Vol. IV); and, second, the genus *Bathynotus* had been anticipated for the same fossil by Dr. Emmons, in 1860, who called it *Pagura* (see *Manual of Geology*, p. 80, figs. 5, 7 and also p. 280).

But the confusion does not stop here; for Mr. Hall proposed, in 1862, the name *Olenellus*. Recognizing that the name of *Barrandia* was untenable, he "proposes to return to the name *Olenellus*" written on the manuscript, but changed to *Barrandia* at the moment of sending it to press. Now Professor Walcott justly refers the *Elliptocephala asaphoides* of Emmons, 1844, to the same genus as the *Olenus Thompsoni;* showing that Emmons has priority, first in calling the genus in 1844 *Elliptocephala* and in 1855 *Elliptocephalus*. If it is necessary to drop *Elliptocephalus* on account of its great similarity with *Ellipsocephalus* of Zenker 1833, also a primordial genus, I think that Emmons' priority ought to be recalled in some way, and the name of the genus may be *Ebenezeria*, in honor of Dr. Ebenezer Emmons and his Taconic system.

The figure of *Barrandia* (*Olenus*) *Thompsoni*, p. 116, is much better than in the first paper of 1859, giving on the caudal shield "a slender pointed spine strengthened by a sharp elevated ridge, extending to the extremity;" but failing to give the remarkable caudal spine, more than two inches long and spade-like, which I have found on a specimen at the Parker's quarry in 1861, and which has been figured since by Mr. Whitfield in *Bulletin Amer. Museum Nat. Hist.*, New York, Vol. I, No. 5, Plate XV, fig. 1, 1884.

Another and important difference between Mr. Hall's paper on the three trilobites of Georgia of 1859 and the one of 1861 (occasioned by the publication of Barrande and Marcou's memoir in December, 1860), besides the creation of the so-called genera *Barrandia* and *Bathynotus*, is the suppression at the end, of the celebrated authoritative note on the age of the Hudson River group, and Logan's ability as a stratigraphist, which is replaced by the following note: "The geological horizon of the shales in which these trilobites occur having been made a matter of discussion among geologists, I shall refer those interested in the subject to the forthcoming report upon the geology of the state of Vermont by Prof. E. Hitchcock" (see p. 119, "Thirteenth Ann. Rep."). The nomenclature and classification contained in that report having been given previously, with the quotation of the sentence, "The stratigraphical view of the Georgia slate, which has been so ably defended by Professor Hall, etc.," it is sufficient to say that Professor Hitchcock was no more aware of the true geological horizon of those trilobites than Professor Hall, and that both had wandered astray in dealing with the paleontological and geological elements of the Georgia formation.

1861 (Sept.). Mr. Marcou in a letter to Elie de Beaumont, written during his visit at the house of N. E. Parker, Georgia, gives the first description of the *Schistes arénacés à trilobites de Georgia*, and places them as a subdivision of the *Schistes de St. Albans* in the Upper Taconic. For the first time also, he signalizes the existence of great lenticular masses of very hard limestone, badly stratified and inclosed in the slates, round the city of St. Albans. (See *Comptes Rendus, Académie des Sciences*, tome LIII, No. 19, 4 Novembre, 1861, pp. 803 to 808, Paris.)

1861 (Nov.). At the 6th of November meeting of the Boston Society of Natural History, Mr. Marcou described, with details and sections, the *Georgia slates* as the middle group of the Taconic. He gave also a history of the discovery of the fossils in the quarry of N. E. Parker. This is the first detailed description of what Mr. Walcott calls *Georgia formation.* The sections drawn on the blackboard were not published until 1880, in Mr. Marcou's paper printed in the *Bulletin Soc. géol. France*, 3e série, tome IX, p. 18: "Sur les colonies dans les roches Taconiques des bords du lac Champlain," p. 24 and Plate II, fig. 1.

The communication to the Boston Society is entitled: "The Taconic and Lower Silurian rocks of Vermont and Canada," by Jules Marcou (*Proceed. Boston Soc. Nat. Hist.*, Vol. VIII, 1861 to 1862, p. 239); and it is at pp. 244, 245 and 246, that the *Georgia slates* are described as a special group.

1862 (Mar.). In the "Report on the Geology of Vermont," by Edward Hitchcock and Charles H. Hitchcock, in two volumes, 4°, antedated 1861, but not published until the end of March, 1862, at p. 357 there is a *Georgia group.* No description of Parker's quarry or any other part of Georgia township is given.

The second edition of Professor Hall's paper on the three trilobites of Georgia, taken

from the "Thirteenth Annual Report Regents' University, New York, 1861 (not 186 0) is here reprinted from p. 367 to 372, under the title: "Note upon the Trilobites of the shales of the Hudson River group in the town of Georgia, Vermont." But the last phrase before the final note is omitted. *Per contra*, a description of a *Graptolithus Milesi* by Professor Hall is added at p. 372.

At the end of the Georgia group, p. 386, there is a Note by Edward Hitchcock expressing his doubt about Barrande's remarks in his "Documents anciens et nouveaux, sur la faune Primordiale et le système Taconique en Amérique." According to Hitchcock, Logan has suggested that "these shales and limestones (of Quebec and Georgia) are subordinate to the Potsdam sandstone" — "a deep sea deposit, going on at the same time with the arenaceous deposit near the shore; whereas Professor Emmons places his Taconic system *below* the Potsdam sandstone, in the same position as the Cambrian and Huronian system. Does he then recognize the Taconic system as understood by its author, or can it be that Barrande has mistaken his meaning?"

In the geological map of Vermont, at the end of Vol. II, Plate I, Messrs. Hitchcock, in the explanation of the colors, place the Georgia slates above the Champlain system (Cambrian), in the Upper Silurian!

Prof. C. H. Hitchcock on the "age of Taconic rocks," in a letter to Mr. J. D. Dana, dated February 10, 1880, and published in the *Amer. Journ. Sc.*, 3d series, Vol. XIX, pp. 236 and 237, says that "there is nothing in the report (on the Geology of Vermont) anywhere favorable to the Taconism." . . . "Within the past two years I have gone over most of the Vermont sections, and have felt that they demonstrated the essential equivalence of the Taconic system with the Potsdam and the overlying limestones and shales (of the Lower Silurian). I have been throughout in essential accord with you and Mr. Wing."

1862 (May). In Vol. III, *Palaeontology of New York*, Part I, Text, Albany, antedated 1859, but not distributed until the end of May, 1862, at p. 525, the paper of the *Twelfth Ann. Rep. Regents' Univ. New York*, by James Hall, is reprinted, with the altered title of: "Remarks upon the Trilobites of the shales of the Hudson River group, with description of some new species of the genus Olenus," instead of, "Trilobites of the shales of the Hudson River group," making a fourth variation in the title of that small paper, in less than three years.

In the *American Journ. Sc.*, January, 1861, p. 123, we read: "The Introduction (of Vol. III, *Palaeontology of New York*) handles with masterly skill the difficult subjects connected with the proper classification of the lower horizons of life in our planet. A review of this important chapter with reference to the views of Barrande will probably appear in our next." That review has never appeared to this day; and the introduction repeats at p. 14, the statement: "From the metamorphic slates of this group (the Hudson River group) on the western slope of the Green Mountains in Vermont, we have three or more species of trilobites, which are of much interest, being representative of a genus, but little known in this country," together with the authoritative note, containing "the testimony of Sir W. E. Logan;" and repeated *verbatim* at the end of the volume, p. 529, we have the whole "proper classification of the lower horizons of life" as understood and maintained by the paleontologist of the state of New York.

1862 (Aug.). In a printed "Letter to M. Joachim Barrande, on the Taconic rocks of

Vermont and Canada," with a "comparative tabular section," Cambridge, Mr. Marcou describes, at p. 5, the *Georgia slates* on the farm of Dr. Hall, east of Swanton, and points out two lenticular masses of very hard blue and whitish limestone, inclosed in the slates and sandstones. The fossils found in the limestone and in the slates are: *Olenellus Thompsoni*, *Ol. Vermontana*, *Conocephalites Teucer*, *Obolella cingulata*, *Orthisina fertinata* and *Camerella antiquata*.

It is in this paper that the announcement is made of the existence of lenticular masses of limestone, more or less globular, distributed without any regular order in all the different divisions and groups of the Taconic system, in Vermont as well as in Canada; and also that at Pointe-Lévis and at Phillipsburgh are found in some of the lenticular masses, *Precursory Center of Creation*, or *Colonies of the Second Fauna* inclosed in strata containing the *Primordial fauna;* a fact not recorded until then in America and showing that here as well as in Bohemia we have *forerunners* and *prophetic types*, specific as well as generic, making their appearance in a period anterior to the one in which they have obtained their full development. Mr. Marcou calls these lenticular masses, *Lenticular precursors*, in order to distinguish them from the lenticular masses containing only primordial fossils, as are those of Dr. Hall's farm at Swanton, which he calls *Lenticular primordials*.

1867.—Prof. C. H. Hitchcock, in a *Geological Map of New Hampshire and Vermont*, does not use the name *Georgia slates* nor *Georgia formation*, as he did in the "Geology of Vermont," in 1862, and in the explanation of colors, we have the following classification, in ascending order.

Laurentian.	Cambrian (Potsdam).
Montalban or Atlantic.	Coos group and calciferous mica-schist.
Huronian.	Cambro-silurian.
Kearsarge and andalusite group.	Taconic schist.
Rockingham and ferruginous schists.	Helderberg.
Cambrian clay slates.	

Another nomenclature somewhat different from the one given in his geological map of Vermont of 1861, but in which he maintains the Taconic as Upper Silurian. The township of Georgia, on the map of 1867, is colored as Potsdam and Cambro-silurian.

1867 (Dec.). Rev. John B. Perry, in a paper entitled: "Queries on the red sandstone of Vermont and its relations to the other rocks," read and published, in the *Proceed. Boston Soc. Nat. History*, December 18, 1867, Vol. XI, uses the name *Georgia slates*, with the same meaning that Mr. Marcou does, giving also the same list of fossils (see Separate, p. 9, 1868).

1880 (Nov.). Mr. Marcou publishes in his paper, "Sur les colonies dans les roches Taconiques des bords du lac Champlain (*Bulletin Soc. géol. France*, 3e série, tome IX, p. 18, Paris), a detailed description of Georgia, with sections in the text and on Plate II, and a geological map of all the area round Georgia, Parker's farm and St. Albans. He uses the name *Schistes de Georgia* and mentions two new fossils, a brachiopod and a *Dikelocephalus*.

1884 (Feb.). The *Bulletin American Museum of Natural History*, New York, Vol. I, No. 5, contains two articles: "Notice of some new species of primordial fossils, etc.," by R. P. Whitfield; and "Geological sections across New Hampshire and Vermont,"

by C. H. Hitchcock. In the first article Mr. Whitfield describes from the Georgia slates the fossils found there, as far back as 1861 and 1862, by Jules Marcou, under the names of *Orthisina orientalis* and *Dikelocephalus? Marcoui*. He gives also a better figure and description of *Olenellus Thompsoni* with the long caudal spine, from a specimen found by Marcou; and finally he adds a new trilobite *Angelina Hitchcocki*, also from Parker's quarry. He regards the Georgia slates and even the limestone at Pointe-Lévis as belonging to the typical Potsdam, without saying if it is the Potsdam sandstone of the village of Potsdam, or at Keeseville, or at any other locality in the state of New York.

Mr. Hitchcock describes several sections. His number "6. Clay slates and argilitic and other schists, supposed to be of Cambrian age. Of these, the *Georgia slates* of the Vermont report contain the *Olenellus* and *Angelina*, etc." At p. 158, he says, "It is just here that the fatal defect of the establishment of the Taconic system, as defined by Emmons, exists. His palaeontological arguments were better than the stratigraphical." Finally, Professor Hitchcock closes his article with some remarks on "Colonies," indorsing Logan's sections at Highgate Springs and Swanton, and the reality of his theory.

1885 (Jan.). "The Taconic system and its position in stratigraphical geology," by Jules Marcou, communicated December 10, 1884, to the American Academy (*Proceed. Amer. Acad. Arts and Sciences*, new series, Vol. XII, p. 174, Cambridge), contains a tabular view of the Taconic, p. 224, where the *Georgia slates* or *Olenellus zone* is placed in the middle of the Taconic. And at p. 231, another tabular view of the Eureka section by Mr. Walcott shows that the lower part of the *Prospect Mountain limestone* of Nevada is regarded by Marcou, as the equivalent of the Georgia slates or Olenellus zone. In this memoir Mr. Marcou gives the History—1837–1881—of the Taconic system and valuable letters of Dr. E. Emmons, Joachim Barrande and E. Billings, addressed to him, from 1860 to 1882, on that question.

1886 (Dec.). Mr. Walcott published his "Second contribution to the studies of the Cambrian faunas of North America (*Bulletin U. S. Geol. Survey*, No. 30, Washington), containing at pp. 15, 16, and 17, a Georgia section, taken on almost the same line as the one given by Mr. Marcou in 1880. He calls the strata "Middle Cambrian = Georgia formation or Olenellus," with a thickness of 4500 feet. The *Georgia slates*, No. 6 of the section, 200 feet, contains, besides the fossils already described, several new species, *Climacograptus? Emmonsi, Orthisina transversa* and *Microdiscus Parkeri;* and also several found before in other places, but not in this locality, before Mr. Walcott's researches at the Parker's quarry.

"The Georgia section is the most complete yet taken in Vermont," says Mr. Walcott, showing that Mr. Marcou's researches limited between Georgia, Phillipsburgh and Chazy, are amply justified as the most important region of the Taconic, north of the Taconic range. In beginning his studies of the Taconic system, at the same spot, twenty-four years after him, Mr. Walcott had a base, on which he was able to improve and correct errors, at the same time that he brought with him his experience and knowledge of the Taconic system of Nevada and the Great Cañon of the Colorado.

Paleontological remarks.— The paleontological part of Mr. Walcott's memoir under the title of: *Description of the Middle Cambrian fauna*, pp. 72–222, is excellent and of great value to the progress of the Taconic question. Apart from a few discrepancies in the synonymy of species, and priority of publications, both easy to correct, I shall call attention only to a few points.

1. *Atops trilineatus* is one of the first primordial fossils described, in 1844, by Dr. Emmons, as a new species and a new genus. Prof. James Hall identified it with *Calymene Beckii*, in 1847, suppressing at the same time the genus and the species. He was followed in his determination by Messrs. Fitch (1849) and Walcott (1879). In 1861, Barrande accepted the view of Emmons, recognizing characters special to the trilobites of the primordial fauna, and he opposed Hall's identification with *Calymene Beckii*.

Mr. Ford in 1871, 1873 and 1880 regarded this trilobite as a *Conocephalus* or *Conocephalites* or *Conocoryphe*, consequently as a true primordial fossil.

Finally, Mr. Walcott, retracting his first view of 1879, considers it as a *Ptychoparia*, a sort of synonym of *Conocephalites* and also a primordial genus. I may add, that Professor Walcott now thinks the fossil is not a *Ptychoparia* (*Conocephalites*).

I have always thought that Dr. Emmons was right in making it a new type having many affinities with the genus *Sao*, and I have, ever since 1860, used the fossil under the name of *Atops trilineatus* and as a characteristic primordial American fossil. From the primitive Taconic region of the vicinity of Troy and in Washington County, New York, it has also been found, first in 1867 at Swanton, Vermont, and afterward at Bic Harbor on the St. Lawrence opposite the Saguenaw river, Canada.

All the different generic names given after that of Emmons are very unfortunate and in direct violation of the law of priority. *Atops* is a good name which ought to be retained. The fossil is not a *Conocephalites*, and even if it were, *Atops* has priority over *Ptychoparia* by three years, for Corda did not create that genus until 1847, while Emmons' figure and description dated from 1844.

2. *Elliptocephala asaphoides*, another of the very few primordial fossils, first found and described by Emmons, is also a good species and a good genus. As I have said already, Prof. J. Hall made unnecessary new names *Barrandia* and *Olenellus* which created confusion without any apology for it; for the name *Paradoxides*, used by both Emmons and Barrande, was sufficient to characterize the fossil until a good and appropriate name could be chosen to replace *Elliptocephalus* if necessary.[1] *Ebenezeria* may be used now, in honor of the discoverer of the Taconic system; but, like Dr. Ebenezer Emmons, I think that it will be best and in accordance with priority to retain *Elliptocephalus*.

3. *Protypus Hitchcocki*, first referred by Mr. Whitfield to the genus *Angelina*, is made the foundation of a new genus by Mr. Walcott. That creation seems unnecessary, for the two fossils referred to *Protypus* belong to the genus *Ellipsocephalus*, Zenker, 1833, a Primordial trilobitic type of Bohemia, which those two fossils represent in the New World.

4. *Microdiscus quadricostatus*, published and established in 1855, is another good creation of Dr. Emmons, rightly referred by him to the Taconic system. The supposition, that it came from the Lorraine shales of Augusta county, Virginia, and is a *Trinucleus*, is, on the part of Professor Walcott, conjectural, and it may lead to curious confusion if accepted without very clear and unquestionable facts. It would have been strange if Dr. Emmons, always so successful in his classifications and paleontology of

[1] "The genus *Ellipsocephalus* was unknown to me at the time of the publication of *Elliptocephalus;* the name, from its similarity, is no doubt objectionable, but I am disposed to retain it for the present" (see Emmons' *American Geol.* Vol. I, Part II, p. 114, 1855).

the oldest palaeozoic rocks, had made a new genus from a specimen of a *Trinucleus;* a genus which, after all, is regarded by Messrs. Salter and Walcott as being a good one when applied to four other fossils, all of the American primordial fauna.

Graptolites zones of America.—Finally, Mr. Walcott, at p. 92, makes strictures on an extract of a letter of Emmons to Marcou, published in "Taconic system, etc." (*Proceed. Amer. Acad.*, Vol. XII, p. 188, Cambridge, 1885), in regard to the beautiful Taconic *Graptolites* referred by Mr. James Hall to the Lorraine shales (Hudson River group). Professor Walcott thinks that "Emmons had not a clear idea of the position of the shales of the Hudson valley that contains the *Graptolites* . . . nor of the shales at Pointe-Lévis carrying the graptolitic fauna." Farther on, he adds, "Professor Marcou refers the strata containing the Graptolites to the Taconic, and places it below the Potsdam sandstone, but I think without either stratigraphic or palaeontologic evidence." Mr. Marcou has given proofs of the Taconic age of the "Black slates" of Emmons at Swanton, Highgate, Phillipsburgh and Quebec, in publishing geological maps, sections and tabular views, repeatedly from 1861 to 1885.

The graptolitic question must be studied not in doors, but in the field, and all that I have seen in Vermont and at Quebec confirms and sustains the opinion expressed by Dr. Emmons.

The Director of the Canada Geological Survey, Mr. Selwyn, says: "Unfortunately in Canada geology, hitherto the stratigraphy has been made subordinate to mineralogy and palaeontology" (see *The stratigraphy of the Quebec group and the older crystalline rocks of Canada*, p. 14, 1879, Montreal), a remark, by the way, of which he made no use himself, and which is equally true for the whole Taconic area in the United States.

It is to be hoped that the paleontologists, who occupy themselves more especially with the studies of Graptolites, will conform to stratigraphy and not force the different zones of Graptolites all over the world, in America as well as in Europe, Asia and Australia, into the same horizon whether they belong there or not.

There are three zones of Graptolites in the Taconic system of eastern America. The oldest is in the St. John group and Georgia slates. The second horizon exists in the Pointe Lévis or Phillipsburgh group, where are the celebrated compound Graptolites, with many others. Then the third zone in the Swanton slates, near Swanton's bridge, and in the Quebec citadel slates at Quebec city and at the island of Orleans. Finally in the Utica and Lorraine shales, there is another graptolitic zone represented by only four or six species at most.

I do not enter into subdivisions of those four different great graptolitic zones, which according to localities can be divided in stages and even in beds; for only local descriptions and minute surveys can give those limited zonal details. But I give two tabular views which show at a glance the great divergence of opinions existing in regard to classifications and nomenclature.

Table A is taken from "C. Lapworth on Graptolites from Lower Palaeozoic rocks" (*Trans. Roy. Soc. Canada*, 4°, 1886, p. 183, Montreal).

I have reduced it to a smaller form, suppressing the names of the species of Graptolites and several names of localities in Canada and New York, but keeping carefully the divisions and classifications of Professor Lapworth.

TABLE A.

SHOWING THE VARIOUS HORIZONS, AND APPROXIMATE GEOLOGICAL AGE OF THE SEVERAL AMERICAN GRAPTOLITIC ZONES, BY CHARLES LAPWORTH, 1886.

Graptolitic Zones.	New York.	Canada.		Systems.
1st Zone.	Lorraine shales (Graptolites). Utica slates (Graptolites). . . .	No Lorraine shales. = Utica slates of Lake St. John and Ottawa. Pre-Utica? or shales of Citadel Hill, Quebec. (An horizon unknown in New York.)		Ordovician System.
2nd Zone.	Trenton and Black river, of Normanskill, near Albany. (Graptolites).	= Pointe Lévis or Trenton and Birdseye (shales of Marsouin river, etc.)		
3d Zone.	Chazy and Calciferous. . . . . (No Graptolites).	= Quebec group of Logan.	Chazy or Levis.	
			Calciferous or Levis and Quebec. Three different horizons.	Cambrian (upper) or Primordial System.

According to his view, the Quebec group of Logan is divided into an upper part, which he calls Lévis or *Phyllograptus* zone of St. Anne river; and a lower part, or Quebec and Lévis (probably of Calciferous age) with three subdivisions or horizons containing *Dictionema* and *Oldhamia*. The upper part is the equivalent of Chazy and belongs to the Ordovician or Cambro-silurian, or upper Cambrian of Sedgwick. The lower part —"probably of Calciferous age"— belongs to the Upper Cambrian of Lapworth (not Sedgwick).

The author recognizes the great difficulty of dividing the Quebec group into two parts, belonging to two different systems, and asks for a "careful study" in order to arrive at "the solution of the great geological enigma of the Quebec group and its puzzling associates." Professor Lapworth says: "The so-called Quebec rocks, of the town of Quebec, . . are not of Quebec age at all. . . They appear to be of greater antiquity than the Utica slates of Lake St. John." In his tabular view, he places them a little below the Utica, as "pre-Utica," above the Trenton, thus creating a group unknown in New York. He also says: "Thus it appears at present that we are destitute of any clear evidence that true Utica and Hudson river (or Lorraine shales) strata occur anywhere along the south side of the St. Lawrence from Gaspé to Quebec." A very important conclusion, differing widely from the classification used until now by the Geological Survey of Canada.

Table B shows four graptolitic zones instead of three, and unite together northeastern New York, western Vermont and the province of Quebec in Canada.

TABLE B.

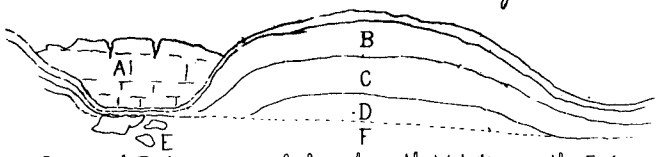
SHOWING THE VARIOUS GRAPTOLITIC ZONES, GEOLOGICAL AGE AND CLASSIFICATION FOR THE NORTHEASTERN PART OF NORTH AMERICA, BY JULES MARCOU, 1887.

Graptolitic Zones.	New York, Vermont and Canada.	Systems.
1st Zone.	Lorraine shales (Graptolites in New York). No Lorraine shales in Vermont and Canada.	Cambrian or Champlain System.
	Utica slates (Graptolites in New York, Vermont and Canada).	
	Trenton limestone, Black river, Birdseye } No Graptolites in New York, Vermont and Canada.	
	Chazy limestone, Calciferous sandstone } No Graptolites in New York, Vermont and Canada.	
	Potsdam sandstone. No Graptolites.	Taconic System.
2nd Zone.	Swanton slates or shales of Citadel Hill, Quebec (Graptolites in Canada, Vermont and New York).	
3d Zone.	Pointe-Lévis or Phillipsburgh formation (compound Graptolites at Lévis and St. Anne river, Canada).	
4th Zone.	Georgia formation, St. John formation } Middle Taconic (Graptolites at Georgia, and near St. John, New Brunswick.)	

The fourth zone of Graptolites is older than any of the zones of Professor Lapworth; and although containing only three species, found at Parker's quarry (Georgia) and at Porter's Brook, St. Martin, near St. John (New Brunswick), is most important, for it shows, without a possible doubt, that the Graptolites made their appearance in America sooner than in Europe (England, Scandinavia and Bohemia).

There is a great gap between the second and first graptolitic zones, during the deposit of the Potsdam, Calciferous, Chazy, Birdseye, Black river and Trenton. In America the Graptolites belong mainly to the Middle and Upper Taconic, or primordial and supra-primordial faunas.

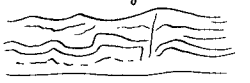
Fig. 1



Section of Parker's quarry, looking from the West towards the East.

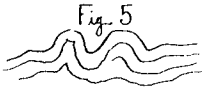
A Lenticular Sandstone.
B Slaty Sandstone.
C Grey Slates with Trilobites, Dip 35° East.
D Black Slates.
E Loose pieces of the Lentille.
F Loose pieces and slabs of Slaty Sandstone

Fig. 4



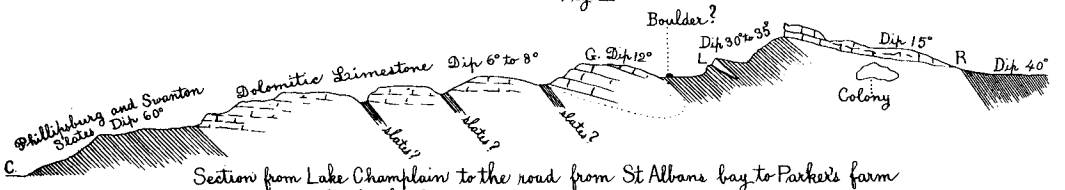
Contorted Calcareous Sandstone at Parker's quarry.

Fig. 5



Contorted Brecciated Limestone at Highgate falls.

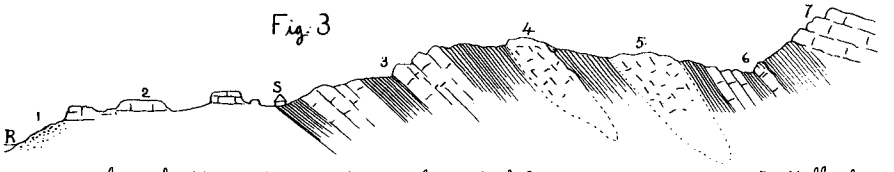
Fig. 2



Section from Lake Champlain to the road from St Albans bay to Parker's farm at 200 yards north of the house.

C Lake Champlain
L Lenticular Sandstone with Trilobites
R Road to Parker's house
G Georgia Lenticular Sandrock with Trilobites

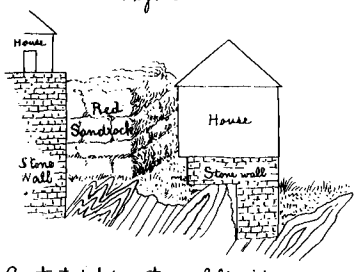
Fig. 3



Section from the Missisquoi river (one mile east of Swanton) crossing over Dr. Hall's farm (now Bullard's farm) to the East a little South.

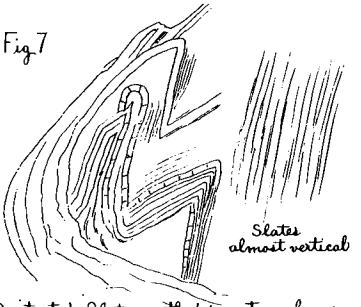
R Missisquoi river
S Sugar cabin

Fig. 6



Contorted Limestone, left side of Highgate falls. The Red Sandrock lies almost horizontally

Fig. 7

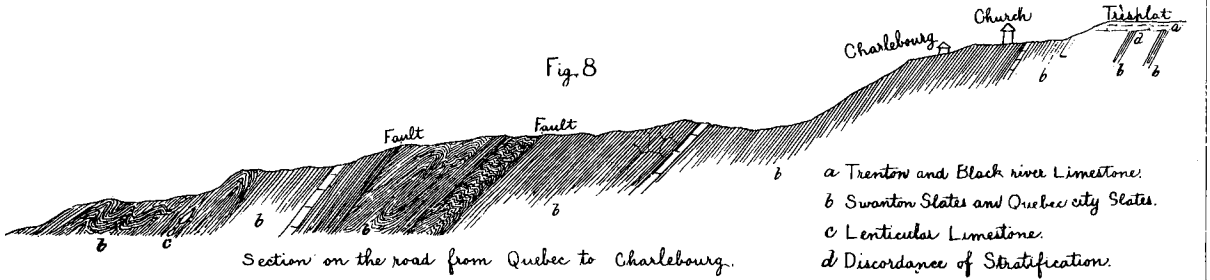


Contorted Slates with Limestone layers, containing Graptolites, at the Hotel Victoria Point Lévis (Quebec)

Fig. 9

Supposed overlapping Fault.

Fig. 8



Section on the road from Quebec to Charlebourg.

a Trenton and Black river Limestone.
b Swanton Slates and Quebec city Slates.
c Lenticular Limestone.
d Discordance of Stratification.

MARCOU'S SECTIONS IN VERMONT AND CANADA.