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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

WITH THE

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY
OF MONTREAL:

B. J. HARRINGTON, B. A., PH. D.
EDITOR.

NEW SERIES,—Vol. 7.

MONTREAL:
DAWSON BROTHERS, ST. JAMES STREET.
1875.

☞ The Editor of this Journal is responsible only for such communications as bear his name or initials.

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THE

CANADIAN NATURALIST

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Quarterly Journal of Science.

ANNUAL ADDRESS OF THE PRESIDENT OF THE NATURAL HISTORY SOCIETY OF MONTREAL, PRINCIPAL DAWSON, L.L.D., F.R.S., *May*, 1872.

As the Society has done me the honor to elect me twice in succession to the office of President, and as my address of last year was occupied almost entirely with local details, I may be permitted on the present occasion to direct your attention in the first place to some general topics of scientific interest, and merely to notice our own more special work in the end of this address. From the many subjects to which your attention and that of kindred Societies has been called in the past year, I may select the following as deserving our attention :—(1) The present aspect of inquiries as to the introduction of genera and species in geological time. (2) The growth of our knowledge of the Primordial and Laurentian rocks and their fossils. (3) The questions relating to the so-called Glacial Period.

There can be no doubt that the theory of evolution, more especially that phase of it which is advocated by Darwin, has greatly extended its influence, especially among young English and American naturalists, within the few past years. We now constantly see reference made to these theories, as if they were established principles, applicable without question to the explanation of observed facts, while classifications notoriously based on these views, and in themselves untrue to nature, have gained currency in popular articles and even in text-books. In this way young people are being trained to be evolutionists without being aware of it, and will come to regard nature wholly through this medium. So strong is this tendency, more especially in England, that there is reason to fear that natural history will be prostituted to the service of a shallow philosophy, and that our old Baconian mode of viewing nature will be quite reversed, so that instead of studying facts in order to arrive at general principles, we shall return to the mediæval plan of setting up dogmas based on authority only, or on metaphysical considerations of the most flimsy character, and forcibly twisting nature into conformity with their requirements. Thus "advanced" views in science lend themselves to the destruction of science, and to a return to semi-barbarism.

In these circumstances, the only resource of the true naturalist is an appeal to the careful study of groups of animals and plants in their succession in geological time. I have, myself, endeavoured to apply this test in my recent report on the Devonian and Silurian flora of Canada, and have shown that the succession of Devonian and Carboniferous plants does not seem explicable on the theory of derivation. Still more recently, in a memoir on the Post-pliocene deposits of Canada, now in course of publication in the *Canadian Naturalist*, I have by a close and detailed comparison of the numerous species of shells found embedded in our clays and gravels, with those living in the Gulf of St. Lawrence and on the coasts of Labrador and Greenland, shown, that it is impossible to suppose that any changes of the nature of evolution were in progress; but on the contrary, that all these species have remained the same, even in their varietal changes, from the post-pliocene period until now. Thus the inference is that these species must have been introduced in some abrupt manner, and that their variations have been within narrow limits and not progressive. This is the more remarkable, since great changes of level and of climate have occurred, and many species have been obliged to change their geographical distribution, but have not been forced to vary more widely than in the Post-pliocene period itself.

Facts of this kind will attract little attention in comparison with the bold and attractive speculations of men who can launch their opinions from the vantage ground of London journals; but their gradual accumulation must some day sweep away the fabric *of evolution*, and *restore* our English science to the domain of common sense and sound induction. Fortunately also, there are workers in this field beyond the limits of the English-speaking world. As an eminent example, we may refer to Joachim Barrande, the illustrious palæontologist of Bohemia, and the greatest authority on the wonderful fauna of his own primordial rocks. In his recent memoir on those ancient and curious crustaceans, the Trilobites, published in advance of the supplement to vol. 1st of the Silurian system of Bohemia, he deals a most damaging blow at the theory of evolution, showing conclusively that no such progressive development is reconcileable with the facts presented by the primordial fauna. The Trilobites are very well adapted to such an investigation. They constitute a well marked group of animals trenchantly separated from all others. They extend through the whole enormous length of the Palæozoic period, and are represented by numerous genera and species. They ceased altogether at an early period of the earth's geological history, so that their account with nature has been closed, and we are in a condition to sum it up and strike the balance of profit and loss. Barrande, in an elaborate essay of 282 pages, brings to bear on the history of these creatures, his whole vast stores of information, in a manner most conclusive in its refutation of theories of progressive development.

It would be impossible here to give an adequate summary of his facts and reasoning. A mere example must suffice. In the earlier part of the memoir he takes up the modifications of the head, the thorax and the pygidium or tail piece of the Trilobites in geological time, showing that numerous and remarkable as these modifications are, in structure, in form and in ornamentation, no law of development can be traced in them. For example, in the number of segments or joints of the thorax, we find some Trilobites with only one to four segments, others with as many as fourteen to twenty-six, while a great many species have medium or intervening numbers. Now in the early primordial fauna the prevalent Trilobites are at the extremes, some with very few segments, as *Agnostus*, others with very many, as *Paradoxides*. The genera with the medium segments are more characteristic of the later faunas. There is thus no progression. If the evolutionist holds that the few-jointed forms are embryonic or more like to the young of the others, then on his theory they should have precedence, but they are contemporary with forms having the greatest number of joints, and Barrande shows that these last cannot be held to be less perfect than those with the medium numbers. Further, as Barrande well shows, on the principle of survival of the fittest, the species with the medium number of joints are best fitted for the struggle of existence. But in that case the primordial Trilobites made a great mistake in passing at once from the few to the many segmented stage or *vice-versa*, and omitting the really profitable condition which lay between. In subsequent times they were thus obliged to undergo a retrogade evolution, in order to repair the error caused by the want of foresight or precipitation of their earlier days. But like other cases of late repentance, theirs seems not to have quite repaired the evils incurred; for it was after they had fully attained the golden mean that they failed in the struggle, and finally became extinct. "Thus the infallibility which these theories attribute to all the acts of matter organizing itself, is gravely compromised." and this attribute would appear not to reside in the trilobed tail, any more than according to some in the triple crown.

In the same manner, the palæontologist of Bohemia passes in review all the parts of the Trilobites, the succession of their species and genera in time, the parallel between them and the Cephalopods, and the relations of all this to the primordial fauna generally. Everywhere he meets with the same result; namely, that the appearance of new forms is sudden and unaccountable, and that there is no indication of a regular progression by derivation. He closes with the following somewhat satirical comparison, of which I give a free translation: "In the case of the planet Neptune, it appears that the theory of astronomy was wonderfully borne out by the actual facts as observed. This theory, therefore, is in harmony with the reality. On the contrary, we have seen that observation flatly contradicts all the indications of the theories of derivation with reference to the composition and first phases of the primordial fauna. In truth, the special study of each of the zoological elements of that fauna has shown that the anticipations of the theory are in complete discordance with the observed facts. These discordances are so complete and so marked that it almost seems as if they had been contrived on purpose to contradict all that these theories teach of the first appearance and primitive evolution of the forms of animal life."

This testimony is the more valuable, inasmuch as the annulose animals generally, and the Trilobites in particular, have recently been a favorite field for the speculations of our English evolutionists. The usual *argumentum ad ignorantiam* deduced from the imperfection of the geological record, will not avail against the facts cited by Barrande, unless it could be proved that we know the Trilobites only in the last stages of their decadence and that they existed as long before the Primordial, as this is before the Permian. Even this supposition, extravagant as it appears, would by no . .eans remove all the difficulties.

Leaving this subject, we may turn for a little to the growth of our knowledge of the older faunas of the earth. A few years ago, when the last edition of Dana's Manual was published, the Potsdam Sandstone formed the base of the Palæozoic series in America, though Barrande in Bohemia and Salter and Hicks in Wales had disclosed lower horizons of life in those regions: now, in America, Palæozoic life descends almost if not quite as low as that of Europe. The researches of Mr. Murray in Newfoundland, together with the study of the fossils by Mr. Billings, have revealed a lower Potsdam, while Messrs Hartt and Matthew by their praiseworthy explorations of the rich primordial fauna of St. John, have enabled us to establish the "Acadian Group" on the horizon of the lower slate group of Jukes in Newfoundland, of the gold-bearing rocks of Nova Scotia, and of the slates of Braintree in Massachusetts.* Mr. Billings, I have reason to believe, will shortly be able to lead us to still greater depths, and as he indicated at a recent meeting of this Society, to introduce us to the fossils of Sir William Logan's Huronian group. It is thus clear that the student of American geology has to add a new or rather very old chapter to his studies of the older rock formations. In connection with this subject, Dr. Sterry Hunt has raised some new and startling questions as to the classification of all the old Metamorphic rocks of Eastern America, and has excited not a little of that controversy, which, like competition in tra`e, is the life of scientific progress. Dr. Hunt naturally attaches a very great importance to the mineral character of the more crystalline sediments;' and in regions where fossils are wanting, and stratigraphy is obscure, he does well to claim precedence for his own special department of chemical geology; though those of us who have been accustomed to regard mineral character, as an un-

* Menevian of Salter, Etage D of Barrande.

certain guide, and to place our reliance on superposition and fossils, will hesitate to give our adhesion to his views, except so far as they may be established by these other criteria, while at the same time we must admit that Dr. Hunt has by his own labours immensely increased the value and importance of chemistry as an element in geological reasonings. Nor can there be any doubt that the promulgation of Dr. Hunt's views, in his address to the American Association last year, has given a new impulse to the study of this subject; and in the coming summer many skilled observers will be engaged in putting to those ancient, crumpled and mysterious rocks, which underlie or are associated with the fossiliferous rocks of Eastern America, the question, to what extent they will respond to the claims made on their behalf by Dr. Hunt. More especially we may look for much from the researches of Sir William Logan, who, released from the details of the business of the Survey, has been for some time applying his unrivalled skill as a stratigraphical geologist to the further elucidation of the intricacies of the structure of the Eastern Townships of the Province of Quebec; and whose matured results, whether in strict accordance with those deduced from the previous work of the Survey, or modified by his later researches, will be of the utmost value with reference to the structure of the whole of Eastern America.

The recent discoveries in the fossils of the primordial rocks have re-opened those discussions as to the terms Cambrian and Silurian which raged some years ago, between the late lamented Sir Roderick Murchison and his contemporary and survivor the venerable Sedgwick. Dr. Hunt has ably reviewed the history of this subject in the pages of the *Canadian Naturalist*, with the view of enquiring as to the best nomenclature for the present; and arrives at conclusions in harmony with those maintained by Sedgwick many years ago. I confess that I have myself long felt that the nomenclature introduced by the great authority of Sir Roderick and the English Survey, and followed somewhat too slavishly on this side of the Atlantic, requires a reform, of which indeed Sir C. Lyell has to some extent set the example in the latest edition of his elements. When Sir Roderick Murchison was preparing the last edition of his "Siluria," I had some correspondence with him on the subject, and ventured to urge that he should himself revise the classification of that work, wishing at the same time to make similar changes in my "Acadian Geology," the second edition of which was then in the press. But Sir Roderick was naturally unwilling to change the boundaries of that Siluria which he had conquered and over which he had reigned, and I contented myself at the time with affirming that the Silurian system, as held by Sir Roderick, really consists of two groups, which should have distinct names; but the question of the names I left to others. Dr. Hunt has now the credit of raising the question in a practical form, and I agree with him that the term Silurian should be restricted to the Upper Silurian of Sir Roderick, which constitutes a distinct period of the earth's history, equivalent to the Devonian or the Carboniferous. The Lower Silurian is really another distinct group, but to avoid multiplication of names, and as it formed the battle-ground of the Silurian and Cambrian controversy, I concur in the view that it may well have the name *Siluro-Cambrian*, while the name Cambrian or Primordial will remain for those great and important fossiliferous deposits extending downward from the Potsdam in America and the Tremadoc in England, and constituting an imperishable monument to the labours of Sedgwick and Barrande.

There remains one point still before leaving this subject. It is the gap between the fauna of the Primordial and that of the Laurentian—the latter still represented only by that Titan of foraminifers, *Eozöon Canadense*. Barrande refers to this gap in his memoir above mentioned; and I had hoped ere this time to have done something to bridge it over. I may here state in anticipation of the results of researches still incomplete, (1) That in rocks of Huronian age in Bavaria and probably also in Ontario, Eozoon has been found. (2) In the middle and Upper Cambrian we know as yet few limestones likely to contain such a fossil, but we have in Labrador species of *Archæocyathus*, one of which I have ascertained to be a calcareous chambered organism of the nature of a foraminifer; though there seems little doubt that others are, as Mr. Billings has shown, allied to sponges. (3) In the Cambro-Silurian, in the limestones of the Trenton group, animals of the type of Eozoon return in full force. The concentrically laminated fossils which sometimes form large masses in these limestones, and which are known as *Stromatopora*, are mostly of this nature, though it is true that fossils of the nature of corals have been included with them. In the Silurian proper, we have the similar if not identical forms known as

Coenostroma, and which according to Lindstrom, form masses in the shales and limestones of Gothland a yard or more in diameter. In all these fossils the skeleton consists of a series of calcareous layers connected with each other by pillars or wall-like processes. The layers are perforated with minute artifices, which are, however, less delicate and regular than in Eozoon, and have in the thickened parts of the walls, radiating tubes of the nature of the canals of Eozoon. (4) On a still higher horizon, that of the Devonian, these organisms abound, so that certain limestones of this age in Michigan contain, according to Winchell, masses sometimes twelve feet in length, and in one place constitute a bed of limestone twenty-five feet in thickness. A beautiful collection of these Devonian forms, recently shown to me by Mr. Rominger, of the State Survey of Michigan, who has worked out these fossils with great care, fully comfirms their foraminiferal affinities, and also shows that in some respects, these Devonian forms are intermediate between the Eozoon of the Laurentian and the *Parkeria* and *Loftusia* of the Greensand and Eocene. We thus learn that these gigantic representatives of one of the lowest forms of animal life have extended from the Laurentian, through the Huronian, Cambrian and following formations, down nearly to the close of the Palæozoic. I have no doubt, that when these successive forms are studied more minutely, they will show like the Trilobites, indications rather of successive creations than of evolution, though in creatures of so low organization the differences must be less marked. The point I now wish to insist on, is their continuance, from the Laurentian down to a comparatively modern geological period.

For the third topic referred to at the beginning of this address, I have reserved little space. In the memoir in the Journal of the Natural History Society already referred to, I have re-asserted and supported by many additional proofs that theory of the combined action of Icebergs and Glaciers in the production of our Canadian Boulder-clay and other superficial deposits, which, fortified by the great names of Lyell and Murchison, I have for many years maintained, in opposition to the views of the extreme glacialists. It is matter of gratification to me to find, in connection with this, that researches in other regions are rapidly tending to overthrow extreme views on the subject, and to restore this department of geological dynamics more nearly to the domain of ordinary existing causes. Whymper, Bonney, and other Alpine explorers, have ably supported in England, the conclusion which after a visit to Switzerland in 1865, I ventured to affirm here, that the erosive power of glaciers is very inconsiderable. The recent German expeditions have done much to remove the prevailing belief that Greenland is a modern example of a continent covered with a universal glacier. Mr. Milne Home, Mr. McIntosh, and others, have ably combated the prevalent notions of a general glacier in England and Scotland. Mr. James Geikie, a leading advocate of land glaciers, has been compelled to admit that marine beds are interstratified with the true boulder-clay of Scotland, and consequently to demand a succession of elevations and depressions in order to give any colour to the theory of a general glacier. The idea of glacial action as means of accounting for the drifts of central Europe and of Brazil seems to be generally abandoned. Lastly, in a recent number of Silliman, Prof. Dana has admitted the necessity, in order to account for land glaciation of the hills of New England, of supposing a mountain range or table land of at least 6,000 feet in height, to have existed between the St. Lawrence and Hudson's Bay, while in addition to the imaginary N. W. & S. E. glacier, flowing from this immense and improbable mass, there must have been a transverse glacier running beneath it up the valley of the St. Lawrence. Such demands amount, in my judgment, to a virtual abandonment of the theory of even very large local glaciers in America in the Post-pliocene period. Thus there are cheering indications that the world-enveloping glacier, which has so long spread its icy pall over the geology of the later Tertiary periods, is fast melting away before the sunshine of truth.

With the exception of that which relates to the Post-pliocene, the geology of Canada has hitherto had to deal only with the more ancient formations. Now, however, there opens up to us a vast field of mesozoic geology in the far west. Already the exploring parties of the Geological Survey are bringing the first fruits of this harvest. The first report of the survey on British Columbia and Vancouver Island is not yet published, but Mr. Selwyn has given us a sketch of his work and that of his indefatigable assistant, Mr. Richardson, in a most interesting and important communication to this Society, a communication which we hail as an earnest of the great things to be expected from the exploration of those great western territories of the Dominion, whose grand physical features of mountain and plain so excite the imagination, and whose structure and natural productions are so different from those of our eastern regions, and therefore so stimulating to our curiosity.

These explorations will, no doubt, serve not only to enrich the annals of science but also to disclose those sources of material wealth which will ere long attract large populations and capital to the Pacific Coast. In the meantime, perhaps, no features excite greater interest on the part of the geologist than the appearance of a comparatively highly altered condition in sediments of no great geological age, and the occurrence of coal in Vancouver Island, associated with animal fossils of Cretaceous date and with a flora composed of exogenous trees of very modern aspect.

In addition to the papers on which the above remarks have been based, we have had two interesting communications from Prof. Nicholson of Toronto, whom we welcome as a valuable addition to our band of workers. Dr. Hunt has contributed a paper on the structure of Mont Blanc; Mr. Billings has given us papers on the Fossils from the Huronian rocks, on the Taconic controversy, on the genus *Obolellina* and on new species of Palæozoic Fossils; Prof. Bailey has given us a paper on the previously little known geology of the Island of Grand Manan; and Mr. Matthew, one on the Surface Geology of New Brunswick. Dr. Anderson, of Quebec, has contributed a notice of a whale captured in the Gulf of St. Lawrence; Mr. Macfarlane has given us his views on the classification of crystalline rocks; Dr. Carpenter has directed our attention to the death-rate of Montreal; and Dr. Smallwood has reported on Meteorological Results for 1871.

I cannot conclude without referring to a new branch of scientific research undertaken by the Society in conjunction with the Department of Marine and Fisheries—that of dredging in the deeper and hitherto unexplored parts of the Gulf of St. Lawrence; and we have to congratulate ourselves on important scientific results obtained in a manner equally creditable to the Government, to the Society, and to its Scientific Curator, Mr. Whiteaves. A knowledge of the fauna of the Gulf has been obtained to a depth of 250 fathoms. Probably one hundred species have been added to the known inhabitants of our Canadian waters. Interesting facts have been obtained as to the distribution and food of fishes; and the attention of the Government of the Dominion has been awakened to the value of researches of this kind. It is hoped that they will be renewed in the approaching summer with larger means and with apparatus for ascertaining more correctly the temperature and composition of the water at great depths.

In conclusion, we have much reason to be satisfied with the measure of success which has attended our work in the past year, and to take courage for the future.

NOTES ON SOME RESULTS OF THE LAST SOLAR ECLIPSE.

By George Frederick Armstrong, M.A. C.E.,

Professor of Engineering and Applied Mechanics, McGill University.

The Solar Eclipse of the 12th of December, 1871, closed a series of such phenomena, presenting features of exceeding interest to science. Commencing in 1865, the Eclipses of that and, with one exception, the six succeeding years afforded opportunities, such as will not again occur for some few years to come, of investigating some problems in Solar Physics by the aid of spectroscopic analysis: many of them being of the first order of importance. It may, therefore, be useful to sum up briefly the results that have so far been obtained.

The untoward difficulties with which the expedition of December, 1870, was called upon to contend, and which partly arose from a hurried organization and partly from the more serious obstacle presented by unfavorable weather—the English suffering from both and the other observing parties from the latter cause only—were not, fortunately, encountered by the observers of the following year.

The principle path of the Moon's shadow during the last Eclipse, as was the case in some previous years, did not traverse any portions of either Europe or America, but was confined to Australia, Ceylon and India. Parties of observation were accordingly stationed on the Gulf of Carpentaria, at Trincomalee (Mr. Moseley's), at Bekul (Mr. Lockyer's party, with Col. Tennant, Mr. Davis, Capt. Maclear and Professor Respighi), at Avenashi

(Mr. Pogson's), at Sholoor (Mr. Jannsen's), at Jaffna and a few other places of less interest.

At the first named Station circumstances prevailed which were disastrous, as far as observation was concerned; at all the others, however, complete success attended the work undertaken.

The almost total failure, in the matter of trustworthy observations, of the Eclipse—mainly visible in Northern Africa, Sicily and Spain—of the preceding year had left physicists in a position of much doubt and perplexity as to a number of very grave questions of science. Those, therefore, who were interested in the solution of these problems were literally on tip-toe of expectation as to what the Eclipse of which we purpose to speak might reveal. And it is encouraging to know that the result has not been disappointing, and that we may now say that the questions that required an answer have received one, and that many differences of opinion among solar observers may thus be considered as finally decided and put at rest.

It is not our intention at this time to attempt anything more than a passing notice of a few points that are of chiefest interest, and upon which light has been thrown by the observational work of the late Eclipse; and among these will stand preeminent such observations as deal with the nature and origin of the Corona,—that sheeny mane of striated and radial structure which, during an Eclipse, surrounds and adorns the Sun's hidden disc, and whose dazzling brilliancy in its more immediate neighbourhood shades off, at a remoter distance, into a halo of silvery grey and hazy indefiniteness of vast dimensions.

Next in importance to these may, perhaps, be regarded those observations which have to do with the extent and position of the Sun's *chromatosphere* (Respighi)—that gaseous envelope, that is, to whose absorptive powers upon the emenations of the light-giving Photosphere is due the presence of the dark lines of Fraünhofer in the Solar Spectrum. And it may be as well to mention that the reason why so much curiosity centres in any spectroscopic observations that it may be possible to make of this envelope, *unassociated with any other of the Sun's surroundings*, is owing to the fact that its existence was first suggested by Professor Stokes, in 1849, on purely theoretical grounds, and was afterwards experimentally demonstrated in the reversal of the Sodium Spectrum by Kirchoff, but nevertheless its presence had not, before the two last eclipses, been, by actual observation, demonstrated.

Upon questions having reference to the Prominences and other immediate surroundings of the Sun—phenomena which can be as well, if not more easily investigated at other times—it is not our intention now to offer any remarks.

It may be said, then, that until the latter part of the year, 1870, the spectroscope had failed to disclose the typical spectrum of that absorbing envelope, now call the *chromatosphere*. But at the close of that year, Professor Young was successful in identifying it during the December Eclipse. It was known to be vaporous from its absorptive action, and might, therefore, be expected to yield a *discontinuous spectrum* of bright lines, corresponding to the dark lines in that of ordinary sun-light. It was suspected also, by Secchi and others, to be shallow in comparison of its associated envelopes. Then again, owing to the amount of diffused light present and the extremely small angle such an object as it was supposed to be would subtend at the earth's surface (not more than *two* or *three seconds*), it was seen to be almost impracticable to obtain any spectroscopic view of it during ordinary daylight. In addition to this, the attention of observers during the preceding Eclipses of the series had been turned to the investigation of what were then more important matters. Hence it was that the spectrum of this member of the Solar surroundings remained undetected until Professor Young, of Dartmouth—of whom, as well as of the other American observers, it is only right to say that the work done by them has universally borne the impress of unfailing care and thoroughness,—succeeded, when observing in Sicily, in obtaining its unassociated spectrum.

This discovery was thus reported by one of his fellow observers, Professor Langley:—" With the slit of the spectroscope placed " longitudinally at the moment of observation, and for one or " two seconds later, the field of the instrument was filled with " bright lines. As far as could be judged during this brief " interval every non-atmospheric line of the Solar Spectrum " showed bright." He adds, " we seem to be justified in " assuming the probable existence of an envelope (*the chromatos-* "*phere*) surrounding the Photosphere, and beneath the Chromo- " sphere, usually so called, whose thickness must be limited to " two or three seconds of arc, (*from nine to fourteen hundred* " *miles*), and which gives a discontinuous spectrum consisting of " all, or nearly all, the Fraünhofer lines, showing them, that is, " *bright* on a dark ground."

Upon the trustworthiness of this discovery, which, let it be remembered, refers to December, 1870, much unreasonable doubt was thrown by some members of other observing parties that had been less fortunate in their operations. However, the time of waiting was not long, for an opportunity of testing its correctness was expected in the following year.

The Eclipse of 1871, the one, that is, with which we have particularly to deal, was of short duration; and Monsoon weather was, moreover, feared about the time of its occurrence. The sequel, however, showed that neither of these circumstances operated disadvantageously, for both Col. Tennant and Capt. Maclear, and perhaps Professor Respighi, who is somewhat doubtful of the exact meaning of what he saw, were rewarded with a fine spectroscopic view of the Chromatosphere itself, and found it to be in all respects similar to the one already described; and so these distinguished observers were, therefore, enabled fully to confirm the previous observation of Professor Young. It may be unnecessary to state that neither Mr. Lockyer nor Mr. Moseley were equally fortunate, since their failure can in no way detract from the weight of positive evidence obtained by others.

Thus then was a prediction, based originally on theory and experiment, borne out by direct observation, and the infallibility of true scientific method once again vindicated.

We must now turn our attention to the Corona and the facts which the late Eclipse has established as to its nature. The Corona consists essentially of two parts, of unequal extension and luminosity; the shallower and brighter next the Sun; the more extended and dimmer extending far beyond the outer margin of the former. It has been proposed to designate the smaller and brighter the *Corona* proper, and the dimmer and more extended portion the *Halo;* a distinction that we propose to observe in what follows.

Various theories have from time to time been propounded as to the nature and cause of the Coronal phenomena generally. One maintained that they are entirely of Solar origin; another that they are due to the effects of the Earth's atmosphere and have no objective existence; while a third attributed them to the effects of lunar diffraction or reflection. The Spectroscope, however, in the hands of Mr. Huggins, told us some time ago that the Moon has no atmosphere. This last theory, therefore, had to be abandoned, and the contest was consequently reduced to a choice between the two others that remained.

The principal questions then, pending at the time of the Eclipse of 1871, were somewhat as follows:—What order of Spectra do the Corona and Halo give? Are they of the same or of diverse orders, or are they blended? At what distance from the Sun's limb can a spectrum be obtained and where is the bounding line, if any, between the Corona proper and the Halo? Is the light of either or both polarised and, if so, how? And finally, what spectroscopic indications are there of the presence of an, as yet, *terrestrially unknown form of matter* in these wonderful solar appendages, if they be such?

To all these enquiries it is satisfactory to state that answers were forthcoming, and of such a kind as to put an end to speculation as to the coronal nature.

In order to make what is to follow clear, it may be proper here to mention that Angstrom in the year 1867, when spectroscopically examining the Aurora Borealis and Zodiacal light, found in both spectra a *bright green line*, of wave length = 5567, supposed to correspond with a *faint* line numbered 1474 on Kirchoff's scale, and grouped by him among the four or five hundred lines of Iron; but not as one of those that are *characteristic* of that metal. On one occasion when the sky was peculiarly phosphorescent, Angstrom detected this same line, not only in the Zodiacal light, but in all parts of the heavens; and on each occasion it was present *unassociated with any other lines of iron;* a fact that may be construed as indicating the presence of some new form of matter, hitherto *unknown*, inasmuch as the only appearance of this particular line with which we are terrestrially acquainted is as a *supposed but insignificant* member of the iron group. During the Eclipses of both 1869 and 1870, Professor Young announced that he had detected this same line in the Corona and Halo, and in a *bright* and characteristic form. And the matter to which this line is supposed to be due afterwards received the name of "1474- matter."

The import of this discovery, supposing it to be valid, cannot fail to be patent to the reader, for it reveals the existence of a new and mysterious form of matter, of which we had no previous conception, present alike in the Aurora, Zodiacal-light, Coronal appendages and even in the interstellar regions themselves; we may say indeed everywhere and all-pervading. What, we at once ask, is its nature and what its function in the economy of nature? But these are questions to which, as yet, we have no satisfactory reply.

The condition of our knowledge of the spectra of the Corona and Halo at the time of the eclipse of 1870, are well stated in Professor Young's summary. He considered that the spectrum of the Corona and Halo consisted of:—

1. "A continuous spectrum without lines, either bright or "dark, due to incandescent dust—that is, particles of solid or "liquid meteoric matter near the Sun."

2. "A true gaseous spectrum consisting of one (1471) or "more lines, which may arise from the vapour of the meteoric "dust, but more probably from a solar atmosphere through "which the meteoric particles move as foreign bodies."

3. "A true sunlight spectrum, *with its dark lines*, formed by "photospheric light reflected from the solar atmosphere and "meteoric dust. To this reflected sunlight is undoubtedly due "most of the Polarization."

4. "Another component spectrum that is due to the light re-"flected from the particles of our own atmosphere. This is a "mixture of the three already named, with the addition of the "chromosphere spectrum, for while at the middle of the eclipse "the air is wholly shielded from photospheric sunlight, it is of "course exposed to illumination from the prominences and upper "portions of the chromosphere."

5. "If there should be between us and the Moon at the mo-"ment of the Eclipse, any cloud of cosmical dust, the light re-"flected by this cloud would come in as a fifth element."

Such a spectrum, as will be seen, is, to use again Professor Young's words, "exceedingly complex."

The correctness of these views was, as has been previously hinted, fully established during the late Eclipse. And among the observations then made the chief place in importance must be given to those of Respighi and Janssen. The former, when observing, adopted the original method of Fraünhofer and placed the prism in front of the object glass, instead of in the position of the eye piece of his telescope; an arrangement whereby a series of overlapping coloured images of the observed object itself are formed, and not merely a number of coloured reproductions of the slit that is usually employed. M. Janssen on the other hand, while using the spectroscope in the place of the eye piece, did so without a slit;—as did also Mr. Lockyer, who observed at Bekul. The telescope employed by Janssen was specially adapted to ensure a very much increased illumination of the image in its field of view. This telescope, although its aperture was 14 inches, had a focal length of only 54 inches; a proportion calculated to produce images fourteen times as bright as in an ordinary instrument. His point of observation, Sholoor, in the Neilgherry Hills, also was at an unusual altitude.

What each of these physicists was successful in seeing may be best gathered from their own descriptions.

Respighi says, in speaking of the coloured zones visible in his instrument when examining the Corona and Halo, that there was "one in the red corresponding with the line C (Hydrogen); an-"other in the green, probably coinciding with the line 1474 of "Kirchoff's scale (the *unknown matter*), and the third in the blue, "perhaps coinciding with F (Hydrogen). The green zone was "the brightest, the most uniform and the best defined. The red "zone was also very distinct and well defined, while the blue "zone was faint and indistinct. The green zone was well "defined at the summit, though less bright than at the base, "its form was sensibly circular and its height about 6′ or 7′. "The red zone exhibited the same form, and approximately "the same height as the green, but its light was weaker and "less uniform." He then goes on to say, "these coloured zones "shone out upon a faintly illuminated ground without any "marked trace of colour. If the Corona or Halo contained rays "of any other colour, their intensity must have been so feeble "that they were merged in the general illumination of the "field."

M. Janssen states his experience thus: "The reasons," he says, "which militate in favour of an objective solar origin (i.e., "of the coronal phenomena) acquire an invincible force when we "examine the luminous elements of the phenomena. In fact "the spectrum of the Corona (and Halo) has not shewn itself "(in my telescope) continuous, as it has hitherto been formed, "(i.e., by those observers, who differed from Professor Young "in 1870), but remarkably complex. I have discovered in it "the bright lines, though much enfeebled, of hydrogen gas, "which forms the principal element of the prominences and "sierra; the bright green line which has already been noted "during the eclipses of 1869 and 1870, as well as some other "fainter lines; and the dark lines of the ordinary solar spec-"trum, notably that of sodium. These dark lines are much "more difficult to perceive. These facts prove the existence of

" matter in the sun's neighbourhood—matter revealing itself in " total eclipses, by phenomena of emission, absorption, and polari- " zation. But the discussion of the facts leads us yet further. " Besides the cosmical matter independent of the sun, which " must exist in the neighbourhood of that orb, the observations " demonstrate the existence of an atmosphere of excessive rarity, " mainly composed of hydrogen, extending far beyond the chro- " matosphere and protruberances, and fed from the very matter " of these—matter erupted with great violence, as we perceive " every day. The rarity of this atmosphere, at a certain distance " from the chromatosphere, must be excessive; so that its exist- " ence is not in disagreement with the passage of certain comets " near the sun."

Although Respighi was only able to detect this *coronal atmosphere*, which he and Janssen were the first fully to make out, at a distance of 7′ or 8′ (*about two hundred thousand miles*) from the Sun's disc, both Capt. Maclear and Capt. Tupman nevertheless succeeded in tracing it spectroscopically as well as by polariscopic means, as far as 45′ (*nearly a million and a quarter miles*); a distance from the Sun which is probably still very far within its true limits.

One more point of interest yet remains, and that is the evidence of the polariscope. A few words will suffice. During the Eclipse of the preceding year, Mr. Raynard and Mr. Pierce found the coronal atmosphere generally to be polarized radially. And this again was the case in Capt. Tupman's observations during the late Eclipse, when, as has just been said, he succeeded in detecting this peculiar state of the light, at a distance of over a millior and a quarter miles from the margin of the Sun; showing that the Corona and Halo in all probability reflect solar light, as well as emit light of their own, and involving as a consequence the presence of *matter* in a region so remote from the Sun itself.

A word as to the labours of the Photographers will conclude these remarks.

It is gratifying to be able to say that, in spite of the brief duration of totality, seventeen good negatives were obtained, somewhat inferior, however, as showing the coronal extension, to those of Mr. Brother's Syracuse pictures of the preceding year, yet nevertheless, of great interest and value. Eight were taken at Bekul, three at Avenashi and six at Jaffna. Mr. Holiday in addition to these made some useful hand drawings also of the passing phenomena of the Eclipse.

IMPRESSIONS OF CUBA.

By G. F. Matthew.

Having been recommended several years ago to try a sea voyage for the benefit of my health, I accepted the invitation of some very kind friends to visit Cienfuegos, a town on the south side of Cuba. My voyage was made in the winter of 1866–67, and I remained two months and a half on the Island. The following pages contain a short description of such of the natural features of the country as still remain impressed on my memory, together with a few remarks upon its people, industries and vegetation.

We sailed from New York on Christmas Day, and after being buffeted about by contrary winds for a fortnight, at length entered the trade-wind region and sped onward toward the West Indies. On entering this zone of "N. E. Trades," the pale misty sky of the North Atlantic is at once exchanged for one of the clearest blue, and the ill defined horizon for one of the greatest distinctness; so that the voyager is no longer left in doubt as to the line where sky ends and sea begins.

The azure ocean in these latitudes has a fascination for one accustomed to the dull green hues of our northern seas, while the floating gulf-weed with its miniature world of living forms, and the new kinds of fishes—reflecting from their sides in metallic tints the color of the waters in which they find a home—are sights upon which the eye dwells with ever increasing pleasure.

With the charming weather which prevails on the southern coast of Cuba during the winter months, the voyager as he creeps along can thoroughly enjoy the ever-changing views presented by that magnificent range of mountains—the Sierra Maestra. This range extends along the coast from near Cape Maysi, the eastern extremity of the Island, to Cape Cruz, a distance of two hundred and fifty miles, and has many sharp peaks of great height. For long distances it rises boldly from the sea, presenting beetling cliffs several hundred feet high.

At the eastern and western ends of this elevated tract of land, walls of rock may be seen to extend for scores of miles along the mountain side. At the eastern end of the Island there are quite a number of them at different heights, and all seemingly quite horizontal. I suppose them to be old coral-reefs marking successive stages in the elevation of the land during the Pliocene and Post-pliocene periods. Mr. Sawkins, in his recently published *Geology of Jamaica*, speaks of an extensive limestone formation of the latter period in that Island, ascribing to it a thickness of 2,000 feet.

Coral walls similar in aspect to those just described, but at lower levels, fringe the coast of Cuba further westward; some are elevated a few hundred feet above the sea, while the tops of others are still washed by the ocean.

The Sierra Maestra has, among its higher mountains, peaks, which in height exceed any of the Appalachian or Laurentian Mountains of North America. They are directly upon the seaboard, and being 8,000 feet high, present a far more imposing spectacle than those of any range in Eastern North America. If one may judge from its jagged outline and steep sides, this range has been thrust up in comparatively recent geological times; and if the movement which resulted in its elevation were cotemporary with those acting upon the ridges thrown up in the western part of the Island, it probably received its present form about the close of the Miocene period. When we sailed by it, the whole southern side, with the exception of a very narrow strip along the shore, was of a uniform brown color. There was thus little to divert the eye from the thin wreaths of mist which could be seen to gather in the gorges among the higher crests, and which told so plainly the history of daily change in the temperature.

In the early part of the day they appeared at elevated points along the mountain, and gradually increased among the upper valleys, and on the shoulders of the hills as the day wore on; till at length they combined in one continuous cloud belt, which hid from view the greater part of the range. Sometimes they would extend more than half way down it sides; but in all cases the higher peaks peeped forth, or stood out boldly above the rolling sea of mist.

Every hour after mid-day added to the density and extent of the cloud-belt, till night came and hid it from view. Next morning the whole body of cloud had disappeared from the mountains, having been swept away to leeward during the night by the trade winds; but could still be discerned far off on the distant verge of the horizon in the direction of Jamaica. As soon as the hot sun made its power felt, and the wind drew in again off the sea, a new wreath of cloud began to gather along the side of the mountains, and increase as before.

After passing Cape Cruz we were driven rapidly along the chain of keys which extends thence nearly to Trinidad, where a spur from the central mountain chain comes down to the coast. The mountains here, though not nearly so high as those at the eastern end of the Island, stand out prominently above the general level of the land, when seen from the sea. They do not extend to Cienfuegos; but on approaching that harbor, a low ridge may be seen extending apparently without any break for a great distance along the shore. On coming close to the land this apparent continuity is interrupted by a slight, inconspicuous indentation, marked by a light-house; this is the opening into Xagua Bay, upon the north side of which stands the town of Cienfuegos. The passage into the bay is narrow and tortuous, but very deep: at a point about half-way in, where it makes a right angle, a fort has been erected to command the entrance to the harbour. The spot is very wild and picturesque; and, from its being on the line of an old highway through this part of the Island, it has received the name of *Passa-caballos* (Horse-ferry.) A very strong current runs past it, and the spot is a favourite fishing and bathing resort for the inhabitants of Cienfuegos. Steep ledges of coral and shell-rag—furnishing shelter and a home to delicate sea-weeds, crustaceans, thorny oysters and other molluscs—border both sides of the passage; and the same rocks stand up in steep, but not very high hills on each side. They are a part of the long, but narrow ridge of limestone, which, for many miles, divides Xagua Bay from the Caribbean Sea.

Judging from the fossils it contains and the light color of the rock it belongs to the white limestone formation (Post-pliocene) described by Sawkins as covering large areas in Jamaica. It is a barrier reef raised upon the older Miocene beds (seen further inland,) but is now elevated a hundred feet or more above the sea.

On the outside of the ridge, but near the passage leading into Xagua Bay, are some short sea-beaches, upon which numbers of shells are cast up by the waves, and are much worn by exposure to the surf.

Among those gathered here by Mr. R. M. Fowler and myself, Mr. Kreebs of Saint Thomas, W. I., recognized the following species:—

Murex coruncerui, Mart.
Strombus gigas,
S. pugilis,
Cassis, sp.
Fasciolaria Tuldyra,
Ranella Cubaniana, d'Orb.
Nassa Antillarum, d'Orb.
Oliva reticulata,
O. parvula, Mart.
Columbella nitida,
Marginella avena,
M. guttata, Dill.
M. apicina, Mart.
Cypræa, 5 sp.
Natica, 2 sp.
Pyramidella dolabrata, L.
Cerithium, sp.
C. septemstriatum,
Nerita, 4 sp.
Modulus perlatus, Dill.
Turbo castaneus, Chemn.
Trochus, sp.
Fissurella Barbadensis,
Emarginula octoradiata, Gml.
Patella pulcherrima?
Bulla maculosa, Mart.
Pecten, sp.
P. zic-zac, L.
Lima, sp.
Spondylus fimbriatus, Men.
Perna alata, Chemn.
Arca Listeri, Pp.
A. squamosa, Lam.
Pectunculus, sp.
Chama, sp.
Cardium medium,
Lucina pecten, Reeve.
L. Jamaicensis, L?
L. Pennsylvanica,
Venus, sp.
V. crenulata, Chemn.
Tellina radiata, L.
T. Cayennensis,
T. immaculata, Lam.
Amphidesma, sp.

Xagua Bay is a beautiful sheet of water, about fifteen miles long and from three to five broad. Several small streams discharge into it, of which the Damuji at the western end is the most considerable. Owing to the narrowness of the outlet, the bay is occasionally (though rarely) so filled with fresh water, poured out by these streams during the rainy season, that the fish and other marine animals living in it are destroyed in multitudes, and cast up on the beach. On its southern side the bay is in most places bordered by steep, rocky hills, among which are secluded coves, once the hiding places of buccaneers. It had formerly a shallow entrance at the eastern end, now nearly filled up, but which, a century or two ago, was open enough for small vessels. In addition to the other advantages they found here, this passage often enabled these marauders to escape punishment.

The town of Cienfuegos was founded by the Spaniards with the object of breaking up this nest of pirates, and has a mixed population of French and Spanish origin. On the north side of the bay the land is low, and the shore indented with numerous shallow coves. Between two of these the town is situated; it is closely built, and contains about six or eight thousand inhabitants. Along the waterside it is bordered with warehouses and wharves; the former are seldom more than one storey high, but are very spacious. Most vessels trading to this port load at the wharves, but such as are of large size move out from the shore to complete their cargoes, owing to the shallowness of the water on this side of the bay. The dwelling houses cover a slope extending from some low hills of marl and sandstone to the shore. The soft yellow rock in these hills lies in beds inclined to the southward at an angle of about thirty degrees; and water taken from the wells sunk in it is strongly brackish and bitter. The inhabitants of the town, therefore, depend chiefly upon supplies of rain-water, stored up in large tanks. Those who are not so fortunate as to possess cisterns are supplied by water carriers, who sell at a high price, *agua dulce* (sweet water) procured from springs in the valley of the Damuji, and brought thence in lighters. This precious liquid costs about as much as ice does with us in summer-time.

The geological formation, to which the yellow or buff-colored beds underlying Cienfuegos belongs, appears to be one of great thickness. I traced it in a northerly direction as far as Caunau, four miles from Cienfuegos, and did not then reach its limit. This was in a line nearly at right angles to the strike of the beds, and the intervening strata, where exposed, appear to have a very regular dip. The middle part of the series consists of beds, finer and more clayey—apparently also more calcareous—than those at the two places named. At Caunau the strata are quite compact and firm, becoming a coarse sandstone. For a mile or two back of Cienfuegos there are numerous fossiliferous layers in the more clayey part of the series, from which I obtained the following forms:—*Balanus*, sp., *Dentalium? Ostrea*, 7 sp., *Anomia*, sp., *Pecten*, 3 sp., Echinoids of two species (one a Scutelloid form,) also a large *Orbitoides*, a sharks tooth, and parts of the test of a crab, including the claws and carapace. Mr. J. Lechmere Guppy of Trinidad, W. I., who has kindly examined these fossils, says they are probably of Miocene age. The formation in which they occur is evidently one of great magnitude and importance, and I have no doubt occurs at many other points in this part of the Island. I should think it to be a mile in thickness where I crossed it. It is probably limited by the Trinidad mountains to the eastward, and does not appear on the lower part of the Damuji, where an older series comes to the surface.

The surface deposits both on this river and at Cienfuegos are of much interest, and especially the estuary-flats along the river itself. These flats exhibit the action of an agency which has played an important part in influencing the accumulation of estuary deposits in tropical regions. In approaching the outlet of the Damuji no break in the long green bank of foliage at the head of Xagua Bay enables one to divine where the river's mouth may be, but the entrance to the stream is betrayed by the flocks of pelicans and other natatory birds which seek their food on the long submerged bar extending out from the entrance. Even within the narrow opening, in what appears to be a broad tree-covered flat submerged by rising waters, there is not for several miles any visible bank to the river, but the waters spread out freely over the mud-flats upon which the mangroves grow. These trees by their great stools of roots and by numerous descending branches which root in the mud, interpose a strong check to the outward rush of the water when the stream is in flood, and cause it to deposit a great part of its sediment before reaching the seas. The mud-banks along that part of the Damuji upon which the mangroves grow are of a yellowish-brown or grey color, and contain shells of a small species of oyster, a mussel, a fresh-water cerite (*Cerithidium*), and a small conical univalve (*Melampus.*) These shells and the smaller organisms entombed in the silt, would add greatly to the fertility of soils derived from the mud-flats, if, through the action of disturbing forces in the earth's crust, they become elevated above the sea-level. Such alluvial tracts exist in the valley of the Damuji, and the indications elsewhere of recent changes in the level of the land render it probable that they exist in most of the river valleys of Cuba. A short distance above the Ferry, where the main-road from Cienfuegos crosses the Damuji, an extensive flat occurs, elevated about ten feet above the river; and at about the same level, near the town of Cienfuegos, there are surface deposits containing marine organisms. These bed rest upon clays, which conform to the inequalities of the upturned and eroded Miocene strata, and are found at different heights, from the present sea level to fifteen feet above it. They cover the bottom and sides of a shallow depression in the land through which a small brook runs and enters Xagua Bay just west of Cienfuegos. The fossiliferous layers rest upon certain buff-colored clays which form the subsoil at many points near the town, and which are covered here and there to a depth of from three to four feet by quartz gravel and sand. The coarser deposits have the aspect of ancient beaches or ridges, formed at the time when the depression in which they lie was a shallow cove extending behind the site of the town.

The shells in these sand and gravel beds are all of littoral species, and the water in which they lived appears to have been subjected to more or less agitation; for they are worn and the valves of the lamellibranchiates are generally severed from each other. The great majority of the species occurring here as fossils are still living on the neighboring coast; and from the relations of the deposit in which they are found, as well as the thinness of the beds, their want of coherence, and slight elevation above the Bay, I had supposed them to be Post-pliocene; but Mr. Guppy, to whom the shells collected here were referred, regards them as "probably Pliocene." The following are among the species occurring here.

Murex brevifrons,	*Bulla striata*,
Strombus gigas,	*Ostræa*, sp.
S. pugilis,	*Perna obliqua*,
Pyrula melongena,	*Mytilus*, sp.
Nerita tessellata?	*Venus cancellata*,
Neritinia virginea,	*Lucina costata?*
Modulus lenticularis,	*L. tigrina* (young),
Cerithium versicolor,	*L. Jamaicensis*,
C. vulgatum,	*Asaphis rugosa*.

At Santa Lucia Brook on the Damuji River there is a deposit of buff-colored, calcareous marl, which at some points nearly fills the little valley through which this stream runs. I had no means of measuring its height above the river, which at this point is a tidal estuary, but think that it may be roughly estimated at one hundred feet. This calcareous mass contains leaves of the jucaro, or olive-bark tree, *Bucida Buceras*, the two mangroves *Rhizophora mangle* and *Avicennia nitida*, a fern, a palm? and fragments of other plants. With these there were a few valves of a large species of oyster and some mussel shells, apparently the same species as that occurring in the surface beds at Cienfuegos.

Intermediate in height between the marl of Santa Lucia brook and the deposits already described near the sea-level, there is another surface layer of a dark color exposed along the slopes of the low hills on both sides of the Damuji. Beds of this nature fill the bottom and cover the sides of a small embayment of the land through which Labarinto Brook (the first one north of Santa Lucia) flows to the river. This deposit is not scarped into terraces like the alluvial flats at lower levels in the valley, but is spread with much regularity over the slopes descending to the river. The soils which it yields are called *tierra negra* (black earth), and are greatly relied upon for the production of heavy sugar crops; canes planted on them are less liable to suffer from drought than on other soils, and do not require renewal for a great number of years.

Higher up on the hill sides about the Damuji, a yellow clay may be seen emerging from beneath the *tierra negra*, and extending upwards—except where denudation has removed it—to the summit ridges on each side of the valley. These clays closely resemble those spoken of in connection with the Post-pliocene deposits about Cienfugos, and correspond to them also in their relation to the overlying beds. They come to the surface at many points in the country around Cienfugos, and are evidently the oldest of the surface deposits in that district. In many respects they are analagous to the yellow loam which, according to Prof. E. Hilgard,* "in most cases forms the subsoil of the Gulf States" being spread over a wide area in the basin of the Mississippi. This deposit was greatly eroded and in many places entirely removed when the submerged tract upon which it was thrown down rose again sufficiently high to bring it within the influence of the ocean surf. Large tracts on the ridge westward of the Damuji have in this way been entirely stripped of their surface covering, leaving the subjacent limestone beds exposed to view. These now present a very picturesque appearance, rising in pinnacles and sharp angular masses above the thin soil: worn as they are by the hot tropical rains which for centuries past have coursed down their sides, these marble pyramids have a striking resemblance to the white tents of a military encampment.

Elsewhere the sea has left upon this ridge and the shoulders of land projecting from it extensive gravel banks, giving further proof of the sweep of the sea over the low ridge separating the valley of the Damuji from the long dry gently sloping plain

* Am. Jour. Sci. Dec., 1871.

which descends westward to the great Zapato Swamp. Such gravelly soils are usually accompanied by loamy lands, which are often occupied as farms for the production of fruit and vegetables, and, when exhausted, as pasture grounds for the herds of cattle used in working the estates. Other tracts of this nature are reserved as wood-lands to supply fuel to the sugar-mills.

On all these higher swells and ridges, where gravel or sandy loam does not form the soil,—as well as on the slopes extending down toward the river, but above the land covered by *tierra negra*—another kind of soil denominated *tierra colorada* prevails. This deposit overlies the yellow clays, but I do not know whether it also passes beneath the *tierra negra*, or terminates at its borders. It is considered a valuable soil for the production of sugar: the canes grown upon it need to be renewed every three years, but the quality of cane-juice obtained from plants grown on this kind of land is regarded as much superior to that yielded by canes grown on the dark lands of the lower levels. *Tierra colorada* varies from cinnamon color to a chocolate-red, and its peculiar tint appears to be developed by the disintegration of older surface deposits and limestones. The red color is brightest in those thin coatings of soil which only half conceal the white limestone ledges on the ridge west of the Damuji, and results from an abundant admixture of red oxide of iron. In following these soils westerly beyond the ridge, and in the direction of the Zapato Swamp, the iron oxide predominates more and more, till at length the thin covering of earth is chiefly made up of little ferruginous nodules of the size of swan-shot. In this direction the soil looses its fertility, and the woods which cover the *tierra colorada* on the Damuji give way to wide wastes of dry land covered with thin grass, and dotted here and there by clumps of low thorny bushes. The barrenness here seems in part due to the want of a subsoil, and the ease with which the surface waters escape into crevices in the limestone rocks below, leaving the soil to be parched by a hot tropical sun.

The clay beds and gravel ridges, which are spread over the surface of the Miocene marls and sandstones between Cienfuegos and Caunau, yield pale buff colored soils, which are cultivated on the farms and small sugar plantations of that neighborhood; but the tillage lands here do not appear to be so productive as those of the Damuji. The clay beds of Cienfuegos are worked for making tiles and brick of which there is a large consumption in the town. In the waste heaps on the sides of the clay pits opened for this purpose, lie numbers of the shells of large snails which have buried themselves in the clay to remain during the dry season.

The land shells of Cuba and indeed of the West Indies generally, are of great interest to the naturalist; not only on account of the profusion in which they occur, but also from the great numbers of species and genera, and the very peculiar forms of some of them. Among the tropical snails, some like *Helix Imperator* and *H. Sagamore* rival in the solidity of their shells the stony gasteropods of the ocean: many shells of the genera *Pupa*, *Cylindrella*, *Cyclostoma*, *Chondropoma* and *Trochatella* are highly colored and strongly marked, like the ocean snails. One *Cylindrella* has straightened out its last coil in the manner of *Magilus*, a marine form of the Indian Ocean; while *Glandina* and *Oleacina* will pass for papery olive-shells. The "agate shells" (*Achatina*) are the giant pulmonates of Cuba and carry on their backs shells which are elegantly formed, prettily marked and of large size. I give here a list of a few species met with when collecting Post-pliocene shells near Cienfuegos, for the names of which I am indebted to Mr. Thomas Bland of New York, to whose article on the land shells of the West Indies I shall have occasion to refer further on:—*Helix auricoma*, Fer.; this species is quite abundant and shews considerable variation; *H. Bonplandii*, Lam; *H. Pocyi*, (young); *H. Cubensis*, Pfr.; *Achatina fasciata*, Muhl, in several varieties, nearly as common as *H. auricoma; Cisula inculta*, d'Orb; *Helicina adspersa*, Pfr.; *H. submarginata*, Gray; *Oleacina solidula*, Pfr.; *Glandina*, sp.

The Damuji has a number of estuary shells, including a small species of oyster, multitudes of which cling to the roots and trunks of the mangroves; also *Cerithidium*, sp.; *Melampus coniformis? Balanus*, sp., and *Mytilus*, sp. The shells of *Cerithidium* and *Mytilus* were found in small numbers in a fresh pond at the mouth of Labarinto brook in company with *Planorbis*, 4 sp.; *Physa*, sp.; *Valvata*, sp.; the fresh-water cerite (*Cerithidium*) is an amphibious animal, climbing on trees, and may have crawled over the low bank which divides this pond from the river.

On both sides of the Damuji, a series of strata are exposed, consisting chiefly of limestones, but apparently separated into two bands by an intermediate body of sandstones. The series as a whole was not well exposed at any of the points I visited; but the limestones, which appear at the river side on the Constancia Estate, and are also exposed in the vicinity of the buildings on Concepcion Estate opposite to it, cannot be regarded as the same with those alluded to in the preceeding remarks on the surface geology of this region. The limestones there spoken of as cropping out on the ridge west of the Damuji are clearly underlaid by sandstones holding Cretaceous fossils; and although sub-crystalline, fine-grained and homogeneous, cannot be regarded as primary. Their lower beds are grey and impure, but did not yield any recognizable fossils: the grey grit and sandstone, however, upon which they rest, contains shells of the genera *Conus* and *Oliva*, several small undetermined bivalves, and numbers of a small echinoid form resembling *Cidcrites*. These organisms were observed in the sandstones, on the hill-side just above the buildings of the Constancia Estate, where both the limestones and sandstones dip westward at a very low angle. I was informed that the sub-crystalline limestones of this group rise to the surface in the Zapato Swamp, where there are sharp pinnacles of rock similar to those already described on the ridge west of the Damuji. Crystalline limestones compose a large part of the strata which rise to the surface again still further westward in the Isle of Pines.

I observed the arenaceous strata of this series at two other points in the river valley, which would if connected carry them diagonally across the stream. The first of these places met with in ascending the river is the *Passa*, or Ferry, on the Cienfuegos road. There are here grey and buff sandstones, containing shells of the genera *Exogyra*, *Ostræa*, and *Inoceramus*. Also at Limones, a farm in a little valley further up, there are beds of dark red and grey sandstone holding shells of the genera *Ostræa* and *Inoceramus*. The sandstones are accompanied by a brown conglomerate holding pebbles of felspar-porphyry and diorite.

The limestones of Constancia Landing and Concepcion Estate, already mentioned, lie along the eastern side of the arenaceous band seen at Constancia buildings and the "Ferry." They are mostly of a pale buff tint, and are replete with organic remains—being in fact Hippurite-limestones. This type of shells (*Hippurites*) of several species, with *Caprinella* and *Caprotina?* abounds in them; and they also contain corals and several kinds of univalve and bivalve shells among which are a large *Oliva*, a

Conus, an oyster of the type of *Ostræa cristata*, *Echini* and sponges. These fossils were seen in a ravine near the buildings of the Concepcion Estate on the eastern side, and at the Landing of the Constancia Estate on the western side of the Damuji.

One feature worthy of remark in the Cretaceous rocks of the district of Cienfuegos is the evidence they give of the extent to which the hardening process has gone in them; this condition of the beds is not limited to the district on the Damuji which I have spoken of, but characterizes them over a large area. In this respect they differ greatly from the strata of cotemporaneous age in the Southern States of the Union; for in hardness and coherence they resemble the carboniferous series of the Maritime Provinces of Canada; but they are not so hard as the Silurian and Lower and Middle Devonian of this region, from which the bituminous matter has been expelled.

The evidence afforded by the Cretaceous and Tertiary rocks of the momentous changes which have occurred in the later geological periods over the whole of the West Indian area, are particularly striking to those who witness in Canada and the Eastern United States indications of violent disturbances in the earth's crust only in periods much more remote. Such movements had ceased here in times long anterior to those in which the *Gryphææ* and *Inocerami* of the Damuji valley lived. While the Caribbean region evinces the action of intense forces in the upheaval of mountain chains during the later Secondary and Tertiary ages, it also gives indications of those gentler oscillations of the earths surface which marks those epochs, as well as the Post Tertiary, throughout the Appalachian and Laurentian regions of the neighboring continent.

Any one who will take the trouble to examine a good map of the West Indies, will observe two strongly marked lines of elevation parallel to each other, namely, the line running through Jamaica, the south side of Hayti, Porto Rico and the Virgin Islands; and that running from the Grand Cayman to Point Maysi at the eastern end of Cuba. These are supplemented on the north by the line of elevations in the Isle of Pines, the Jardin Cays, &c.; and on the south by the range indicated in the Seranella, the New Shoal east of it, and the islets off the Carabasca Lagoon. These E. to W. ranges with the N.W. to S.E. courses of some important mountain systems in the large islands, Cuba and San Domingo, combine to give their present outline to the greater Antilles. Another system of submarine elevations evidently governs the arrangement of the Windward Islands; for if the position of the shoals and banks connected with them be traced, it will be observed that they also are arranged in parallel and overlapping groups. In this case, however, it will be found that the ridges have a S. to N. course, not an E. to W. one, as in the Greater Antilles. The point where these two mountain systems meet (St. Thomas, &c.) is even yet the scene of devastating earthquakes.

The mountain chains which I have attempted to describe are the frame-work or skeleton of a large continental area now submerged, and of late years have yielded some curious and interesting proofs of the changes which this whole region has undergone. Mr. Thomas Bland, well known for his study of the land shells of the West Indies, in an article lately published by him,* presents some valuable information bearing upon the past physical history of the Windward Isles. From the observations of the British Admiralty Surveyors, he shews that the elevation of these islands and the adjacent sea-bottom to the height of forty fathoms above the present level, would unite the whole group of the Virgin Islands with Porto Rico, and would make six large islands of several groups of islands extending southward to the coast of South America. And it would appear that a connection even more complete than is thus foreshadowed, existed in comparatively late geological times; for he tells us that "taking a wide view of the land-shell distribution in the West Indies, it may be said that the fauna of the islands on the northern side of the Caribbean Sea, from Cuba to the Virgin and Anguilla banks, was derived from Mexico and Central America; and that from the islands of the eastern side, from the Antigua and St. Christopher banks to Trinidad, from tropical South America. It is noticeable that the mountains in the former islands, range generally from west to east, but in the latter from south to north, except in Tobago and Trinidad, where they are parallel with, or in the same direction as the coast mountains of the adjacent continent. The present geological condition of the islands affords ample evidence of the lapse of vast periods of time in the earlier Tertiary epochs, during which the limestone formations, extensively developed in most of the islands, were deposited.

* Am. Philosop. Soc. N. York, Mar. 3, 1871.

The white limestone of Jamaica, referred to by Sawkins (*Geology of Jamaica*, London, 1869) to the Post-pliocene, covers more than three-fourths of the Island, and is computed at 2,000 feet in thickness. It rests on the yellow limestone (Miocene) which, he remarks, during the deposition of the former, "sank to great depths, in some places apparently 3,000 feet, so as to permit the growth of those great coral structures, from the debris of which the enormous development of the white limestones has been derived. The lapse of time required for these important phenomena cannot be easily realized by the imagination." Mr. Bland proceeds to say "that the islands, or some of them, were formerly united and formed part of an ancient continent, may, it would seem for various reasons, be inferred." Referring to the Anguilla cave remains, Prof. Cope remarks (*Proceed. Acad. Nat. Sci.* Phila. 1868) "that the Caribbean Continent had not been submerged prior to the close of the Post-pliocene, and that its connection was with the other Antilles, while a wide strait separated it from the then comparatively remote shores of North America." Mr. Bland adds "that the occurrence with the Anguilla fossils of a land shell of a species now living, points to the age of the existing fauna, but the marked difference, both generic and specific, between the present land-shell fauna of the islands upon and to the north and west of Anguilla bank, and those to the south of it, may be taken as evidence of their early and continued separation."

It is not a little remarkable that the Caribbean Continent, whose former existence is thus revealed to us, should have so nearly coincided in time with the Glacial Period in North America. Could this mass of land, the greater part of which received its inhabitants from Mexico and Central America, have closed the outlet of the Caribbean Sea? The existence of such a barrier would go far to explain the extreme cold of this period in North America; for had there been at this time no outlet from the Caribbean Sea to the Gulf of Mexico, the tepid waters which enter that sea on the east and pass out again by the Florida passage and Gulf Stream, would have been compelled to commence their journey northward at a point much further east than they now do, and so would not have flowed along the North American coast, nor carried to Northern Europe the temperature of low latitudes. It is possible that the Antilles may have been populated in successive stages from Central America and Yucatan, without actually closing the strait which unites the Caribbean Sea with the Gulf of Mexico; but the near coincidence of land expansion here with the Glacial period at the north, is suggestive of a more complete separation. Such a parting of these two seas and the elevation of the mountain chain of which the Windward Isles are the emerged crests, would also account for the meeting of the two land-shell faunas of the West Indies in the islands furthest to windward, a circumstance difficult of explanation except upon the hypothesis of a continuous terrestrial road from the South American Continent as well as from Mexico. Mr. Bland shews that while the Cuban genera diminish in the number of species as we proceed eastward through the chain of the Greater Antilles, the South American genera are reduced in number as we go northward along the chain of the Windward Isles. Both lines of migration meet in the Anguilla group, the most north-easterly part of the old Caribbean Continent now remaining above the waves.

But while it would thus appear that the West Indian land area was formerly of much greater extent than now, there are, on the other hand, indications which point to a subsequent reduction in size of some of the Islands, much below their present extent. Of the larger animals which lived on the Anguilla group at a period comparatively recent, none are now to be found; nor were any existing, either here or on the larger islands, when Columbus discovered the Indies. There are no indigenous animals of large size in Hayti; and the largest in Cuba is a small rat-like creature, dwelling in trees, called *jutia*. From this it may be inferred that at some late period the Antillean region had been rendered untenable for large animals. Perhaps nothing would conduce more to this result than the engulfment of the Caribbean Continent, leaving only small isolated patches of land above the ocean. In most cases such islets would be sharp mountain peaks, places where the larger mammals could with difficulty maintain their existence and propagate their kind. From what has been previously said it will be seen that a submergence of this nature has occurred in Cuba, the largest of these islands, in times which, geologically, are quite recent; and it is probable that most of the other islands shared in the submersion which took place in the Greater Antilles. In time other movements in the earth's crust led to a re-elevation of this region; the plants and animals inhabiting it—for a time confined to small areas—again spread abroad over the emerging land, and the West Indies assumed the appearance which they now present to us, having, as regards their fauna, two groups, one with South American, the other with Mexican affinities.

It is not a little curious that when Columbus discovered these islands, he found them occupied by two races of men—the warlike and aggressive Caribs inhabiting the Windward Islands, and the mild and docile Indios dwelling in the Greater Antilles.

(*To be continued.*)

GEOLOGICAL FEATURES OF HURON COUNTY, ONTARIO.

By John Gibson, B.A.

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Before commencing a description of the geological structure of this County, a few words on the physical outlines of the district are necessary. Situated on the eastern shore of Lake Huron, and bounded on the north by the County of Bruce; on the east by the Counties of Wellington and Perth; and on the south by the Counties of Middlesex and Lambton, this portion of Ontario is not only remarkable for its natural scenery and fertility, but has of late years, through its boundless resources of rock salt, attained a somewhat conspicuous position in the commercial world. Generally speaking the character of the region is gently undulating, with here and there a few limestone outcrops and escarpments on the north-eastern limits, which, by their disintegration, have to no small extent enhanced the quality of the surrounding land. The average altitude above the sea-level is about 950 feet, although between the Townships of Tuckersmith and Hibbert there is a ridge which rises to a summit-level of 1,050 feet. The streams as a rule are small, and undergo rapid oscillations of level, increasing in the spring to torrents of considerable volume, and conspicuously diminishing towards the fall, when numerous small deltas are formed in the low lands, composed for the most part of thin alluvial accumulations. The Maitland River which forms the dividing line between the Townships of Goderich and Colborne is exceedingly tortuous in its course. It was formerly denominated the *Red River* by the

Indian traders—a name which was probably given it from the color of its waters, which, although perfectly transparent, are generally of a reddish-brown tint. The Indian name for the river is *Menesétung*. Near its mouth the stream is broad, and its bed is composed of course gravel and sand, underneath which a moderately thick stratum of peat has recently been discovered; but, after ascending it for a few miles, the channel becomes contracted, forming as it were a ravine-like basin, denuded by the action of its waters in the limestone fundamental rocks of the locality. The Bayfield River, on the other hand, drains the central, or rather the more southern portion of the County, and flows into the same waters some twelve or thirteen miles south of the *embouchure* of the Maitland. The only other river of importance is the Rivière aux Sables (South) which forms the southern limit of the County. Flowing at first in a north-eastern direction, and bounding the Township of Bosanquet on the east, it makes a bend at its northern extremity, then running nearly parallel with the coast for about ten miles, it enters the Lake. Extending along the western limit of the County, in a north and south direction, lies a remarkable ridge composed of water-worn gravel and fine sand, whose general contour is parallel to the present margin of the Lake. Conforming to the irregularities of the coast for about sixty miles, and at an average distance from it of a mile and a half, it reaches the sandy flats of the Rivière aux Sables, and is finally lost. The western slope of this lacustrine terrace inclines gradually towards the present lake beach, and within this limited area, deposits of shell-marl are frequently found. Future researches will no doubt prove the existence of other terraces lying more to the eastward, which will doubtless throw much light on the former physical features of this lake-area. Our terraces are monuments of great geological value, indicating to a certainty the former submergence of our land under the waters of a vast fresh-water inland sea.

Throughout this tract of country there is ample evidence of denuding forces at work, both prior and subsequent to the Glacial Period. The high clay cliffs along the margin of the lake, and the numerous ravines and valleys, which are so conspicuous along the courses of the above-named rivers, afford unmistakable proofs of the former physical conditions of this region.

The palæozoic strata of this western portion of Ontario are everywhere covered by the vast accumulations of the Drift Period, which have to such an extent obliterated all access of approach that their study can only be of the most partial nature. It is only along some of our river channels, and at intervals on the margin of the lake, that there is sufficient room for either stratigraphic or palæontological investigations. The fundamental rocks of this district belong, with but one or two exceptions, to the Corniferous limestone formation of the Middle Devonian system. These Devonian rocks of America, as laid down by the New York geologists, consist of the following grand sub-divisions or Periods, viz.: 1. The Oriskany sandstones, 2. Corniferous limestones, 3. Hamilton shales and sandstones, 4. Portage and Chemung groups, and 5. The Catskill red sandstones. The following may be given as a table shewing approximately the geological position of the different formations observed either as outcrops or by borings in the area in question:—

Middle Devonian.	Corniferous limestone formation.	
	Onondaga limestone.	
	Schoharie grit.	
Lower Devonian.	Cauda-galli grit.	
	Oriskany sandstone.	
Upper Silurian.	Lower Helderberg group of Vanuxem, including the Tentaculite limestone, or so-called Water-lime sub-division.	
	Onondaga formation, or Salina group of Dana.	
Middle Silurian.	Guelph and Galt limestones.	
	Niagara formation.	Anticosti group.
	Clinton "	
	Medina "	

Of the subdivisions of the Middle Devonian System only one is found in the locality under consideration. This is the Corniferous limestone formation, which forms by far the greater portion of the underlying surface rock. The Lower Devonian is not apparently represented in this County, although numerous fragments of the Oriskany sandstone are scattered here and there on the surface of the ground as angular and evidently lately detached erratics. The rocks of the Lower Helderberg group of the Upper Silurian series are, with the exception of the Tentaculite limestone or Water-lime beds, entirely wanting in Ontario. This division is described by Vanuxum as being essentially a dark blue magnesian limestone, with interstratified drab-colored beds which yield by calcination a very valuable hydraulic cement. It is met with in two localities in the County, and in each presents similar lithological characters. The Onondaga Salt group, or Salina formation of Dana, is found to extend under the whole

County, as far as can be ascertained by borings, forming the foundation rock, so to speak, of the Corniferous limestone, and where this is absent, immediately underlying the so-called Water-lime beds.

The Guelph formation—the uppermost layer of the Middle Silurian series—is only observed by means of borings at a depth of about 1,000 feet from the surface of the ground, and underlying the most recent deposit of rock salt. Of the presence of the Clinton and Medina formations underlying the rock-salt and gypsiferous shales of the Salina group, we have but doubtful evidence; and it is only by means of specimens of rock brought up by the sand-pump, during the operation of boring, that we arrive at the probability of their existence within the average depth of 1,150 feet from the surface. The more important exposures of rock observed within the limits of this district are given in the following list proceeding from north to south:—

1. The escarpments in Howick.
2. The outcrop on the falls of the Ashfield River.
3. The outcrop between the Townships of Ashfield and Colborne.
4. The outcrop on the Maitland, one-half mile from Goderich.
5. The outcrop on the 1st lot of the 1st range of Colborne.
6. The outcrop on the Maitland, 1½ miles from Goderich.

The Corniferous limestone which is the essential rock-component of the above exposures, occupies in Ontario a superficial area of about 6,500 square miles. It is, comparatively, a pure limestone, containing no traces of magnesia which to a great extent enters into the composition of many of our calcareous formations. Its beds are abundantly charged with organic remains, some of which are little more than aggregates of chalcedonic quartz with intermingled calcium carbonate. Numerous beds of chert or hornstone are also especially characteristic of these limestones, giving the name Corniferous to the formation.

1. Throughout the Township of Carrick, and extending south into Howick, occur numerous outcrops of limestone, forming escarpments from twenty to thirty feet in height. These consist for the most part of blue and grey limestones of the Corniferous formation. Their sharp outlines and acute indentations seem to point to the existence of violent denuding agencies, probably contemporaneous with the re-elevation of Western Ontario towards the end of the Glacial Drift.

2. At the falls of the Ashfield River, about a quarter of a mile from its mouth, occur thin beds of calcareous sandstones, interlaminated with silicious limestones, containing but scanty traces of animal life; the only species identified being *Spirifera bimesialis* (Billings). These fossiliferous beds immediately overlie the apparently unfossiliferous Tentaculite limestone, which, about two miles to the south-east, crops out only a few inches above the waters of the Lake.

3. Where the boundary line between Ashfield and Colborne strikes the Lake, near Port Albert, there is a cliffy outcrop facing the water, of a few feet in thickness, which is observed at intervals along the shore for about a mile. The rocks here exposed are entirely destitute of fossils, and consist of the following succession of beds:—

1. Yellow dolomitic limestone. 2. Thin beds of limestone filled with chert. 3. Dark grey sandstones more or less bituminous. 4. Thin limestones, with numerous crystals of calcite.

The lithological character of this outcrop at once indicates the existence of the Tentaculite limestone or Water-lime group. This formation is here found to rest directly upon the Salina shales and limestones, and to immediately underlie the Corniferous formation, the intermediate portions of the Lower Helderberg group being apparently unrepresented. In Western New York, and in some other localities in Ontario, where strata of this division are observed, a few fossils occur. The more characteristic forms met with are *Leperditia alta*, *Tentaculites ornatus*, and *Eurypterus remipes* (DeKay)—the latter crustacean form having been also discovered, according to Keyserling, in the Upper Silurian limestones of the island of Oesel in Russia.

4. About half a mile from the town of Goderich, on the banks of the Maitland, beds of yellowish calcareous sandstone, and dark grey dolomitic limestones, holding lenticular crystals of calc-spar, are exposed for a considerable distance along the river margin. They belong to the Water-lime group, and are entirely destitute of fossils.

5. Ascending the river for nearly five miles, strata of yellowish limestone interlaminated with grey slaty limestone in thin layers are observed. They belong to the Corniferous formation, which, a few miles to the S. E., attains a total thickness of 200 feet, as shewn by the recent borings for salt. The absence of this formation a few miles to the westward where the Tentaculite

limestone forms the fundamental rock of the district, may be accounted for, partly by powerful denudation during the upheaval of this area from the sea-bottom, and partly by the south-eastern dip of the strata. Here the beds are replete with fossils in a more or less silicified condition, the more important species being as follow :—

Zoophyta.

Fistulipora Canadensis, Billings.
Favosites Gothlandica, Goldfuss.
——— *hemispherica*, Shumard.
Syringopora Maclurea, Billings.
——— *Hisingeri*, Billings.
Zaphrentis prolifica, Billings.
——— *gigantea*.
Heliophyllum Eriense.
——— *Canadense*, Billings.
Favosites Basaltica, Goldfuss.
Michelinia convexa, D'Orbigny—the large cell openings being entirely silicified in most instances.
Eridophyllum Simcoense, Billings, and species of the following genera : *Phillipsastrea*, *Clisiophyllum*, *Diphyphyllum* and *Cystiphyllum*.

Brachiopoda.

Orthis Livia, Billings.
Strophomena rhomboidalis, Wahlenberg.
——— *ampla*, Hall.
Streptorhynchus Pandora, Billings.
Rhynchonella Thalia, Billings.
Pentamerus aratus, Conrad.
Spirifera duodenaria, Hall.
Stricklandia elongata, Billings, formerly *Pentamerus elongatus* of Vanuxem.
Atrypa reticularis, Linnæus, also occurring in the Wenlock limestones of Great Britain, in Sweden, Bohemia and in the Ural Mountains of Russia.

Lamellibranchiata.

Conocardium trigonale, Conrad.
Vanuxemia Tomkinsi, Billings.

Gasteropoda.

Loxonema Cotterana, Billings.
Euomphalus de Cewi, Billings.

Of the Cephalopoda only one or two undetermined species occur; whilst the Crustacean representatives are included in the genera *Phacops* and *Dalmannites*.

These fossil species are more or less common to the whole range of Corniferous limestone in the district to which the present observations are confined. Their specific characters have been minutely examined and described by E. Billings, F.G.S., of the Geological Survey of Canada, to whose very elaborate contributions to palæontology the writer is chiefly indebted for descriptions of such fossil types as come under review in this paper.

6. Descending the Maitland for three or four miles from the

last-mentioned outcrop, limestone beds occur in cliffs skirting the river margin. The uppermost beds of grey limestone, holding intercalated crystals and silicified organic remains, belong to the Corniferous formation; whilst the underlying strata of bluish limestone and fine-grained sandstone with irregular crystals of calc-spar, denote the presence of the Water-lime group. We have here exposed in one cliff two different formations belonging to two totally different geological periods; the uppermost or Corniferous belonging to the Middle Devonian System, and the underlying one or Tentaculite limestone being of Silurian age. The numerous intermediate formations, or those which in the geological scale intervene between the formations in question, were being slowly deposited in other localities while the Tentaculite limestone was for ages above the level of the ocean, or at least formed the basin of a very shallow expanse of water, uninfluenced by any currents whatever. Then immediately subsequent to the deposition of all these formations preceding the Corniferous, the long stationary Tentaculite limestone was gradually submerged to a depth of several hundred feet, and on its unruffled surface was deposited the Corniferous sediment, which subsequently was upheaved above the ocean, remaining comparatively motionless until about to be covered by the waters of the Glacial sea.

South of the Maitland river, no exposures of rock have been met with in Huron. Along the valley of the Bayfield we look in vain for the appearance of the underlying rock, the river through its whole course flowing over grey and blue clays of the Quaternary age. But even here something of geological interest awaits us. About three miles in a direct line from Lake Huron and lying partially buried amid the clays along the river margin, there is exposed what seems to be an outlier of a formation apparently higher in the scale than the Corniferous. Its beds are characterized by an extraordinary profusion of organic remains; the uppermost ones containing vast quantities of fragmentary Crinoidal stems which mark in a special manner the presence of certain strata of the Hamilton formation. Viewing it alike from a lithological and a palæontological point of view, the inference would naturally be that we have here an outlier of the Hamilton formation divided from the main area by denudation, and manifestly proving the former extension of these higher deposits along the slopes of that synclinal, whose course from Lake Huron to Erie is a somewhat unique feature in the physical geology of Western Ontario.

NOTES ON THE MARINE CLAYS OCCURRING AT THE RAILWAY CUTTING ON THE LEFT BANK OF THE TATTAGOUCHE RIVER.

By Rev. C. H. Paisley.

The deposit to which these notes refer is situated in Gloucester Co., N.B., about 2½ miles from Bathurst, on the left bank of the Tattagouche River, where it is crossed by the Intercolonial Railroad. It is 60 feet* above the river at low water, and 162 feet above the sea. The cutting that exposes the deposit is not entirely through, so that our information cannot be said to be complete. Near the highest part of the cut yet exposed, the bank presents a surface of about 40 feet, and gives the following section:

	Ft.	Ins.
1. Soil bearing spruce and fir trees	1—2	0
2. Coarse gravel	6—8	0
3. Sand, which. with an occasional thin layer of reddish clay, reaches a thickness of	10–12	0
4. Yellowish clay		9
5. Reddish sand	1	3
6. Reddish-yellow clay with threads of sand	1	8
To this depth the deposit seems to be non-fossiliferous.		
7. Greenish sand with an occasional valve of *Mya*, and innumerable minute fragments of shells, giving the bed such an appearance as is presented by the sand on the sea shore to-day	1	8

8. Coarse sand and reddish clay, so intermingled that, in some places, it is impossible to detect any stratification. In the sand which, on penetration for 1 foot, is found to be stained with iron rust, and which on exposure for a few hours becomes hard as a soft sandstone, occur occasional small angular fragments of quartz, slate, serpentine, &c., varying from 1 oz. to say 5 lbs. in weight. In many parts the clay assumes the form of nodular concretions, interstratified with

* These measurements give the heights to the level of the Railway, so that to get the height of the top of the deposit it will be necessary to add about 40 ft. They are both taken from high water mark at Campbelton, Restigouche ; but the difference between that and the Bay Chaleurs is very trifling.

the sand, and varying from the size of a pea to that of a hen's egg. In other parts the stratum of clay can be detected only by its presence in certain shells when taken from the bank. Very fossiliferous. (See list of fossils below.) Varying from almost a thread to 2 0

9. Reddish sandy clay. For fossils *vide infra*. Average thickness about 2 6

10. Red and blue clays. Tough. So interstratified as to present a beautiful banded appearance. An occasional *Mya* or *Natica* occurs, but so much decomposed as not to stand removal. This bed extends downward to the level of the road, say 5 or 6 feet, but how far below there is no means of determining......... 6 0

Although fossils are found sparsely in the lower part of No. 7 and in the upper part of No. 10, the fossiliferous layer may be said to consist of Nos. 8 and 9.

In No. 8 I have found the following as determined by Dr. Dawson, viz.:

Saxicava rugosa.
Mya arenaria.
Also young shells of the same (not very numerous).
M. truncata.
Leda pernula.
—— *glacialis.*
Nucula tenuis (*expansa*) (scarce).
Aphrodite Grœnlandica.
Macoma calcarea.
——— *Grœnlandica.*
Cryptodon Gouldii (?).
Natica clausa (*affinis*).
Buccinum undatum.
Balanus crenatus.
——— *Hameri.*
Mytilus edulis.

In No. 9 I have found:

Mya arenaria. Very abundant.
—— *truncata.* Rare.
Nucula tenuis. Abundant.
Balanus crenatus.
——— *Hameri.*
Young *Mya* in great abundance.

As it is almost impossible to tell in which stratum of the fossiliferous bed (i. e. whether in the sand or clay) the fossils occur), I will give the material with which they were filled when removed from position:

Saxicava, *Leda glacialis*, *L. pernula*, *Buccinum*, *Natica*, *Aphrodite Grœnlandica*, *Balanus* almost invariably with sand, *Macoma calcarea* and *M. Grœnlandica* sometimes with sand and sometimes in clay, but more frequently with the former, *Mya arenaria*, *M. truncata*, young *Mya*, *Nucula tenuis*, *Mytilus edulis* almost invariably with clay.

I have examined a number of the clay concretions mentioned above, but have not been able to find in them any fossil remains.

The right-hand bank of the river I examined in a cutting made to the same level as that on the left, but found no fossils. The only exposure was a bed of coarse reddish gravel.

The overseer of the railroad bridge now being built in the locality informed me that in digging 8 feet below the level of the river, he found that the rock to which he came inclined in opposite directions on opposite sides of the stream. If this be so the Tattagouche River will occupy the crack in an anticlinal axis, and the deposit examined in these notes will occupy the side dipping towards the sea.

BATHURST, NOV. 19, 1872.

EPIZOOTIC INFLUENZA IN HORSES.

A paper on this subject was read by Mr. D. McEachran, V.S., before the Natural History Society in December last, and as the subject is one of much interest, we publish a somewhat lengthy abstract, being unable, from want of space, to give the paper in full.

Mr. McEachran begins by stating that diseases which attack a number of persons at the same time, and which are supposed to depend upon some atmospheric influence, are denominated *epidemic;* while those of a similar nature, but occurring among the lower animals, are termed *epizootic.* The term *zymotic*, suggested by Dr. William Farr, is, however, more frequently employed in medical nosology than either of the above.

In the greater number of these zymotic diseases the blood seems to be especially acted upon by poisons, and is found to undergo important changes, both chemical and histological. The poisons which are supposed to produce these changes are said to be of organic origin, either derived from without or generated within the body. In the living animal a double process is continually going on, a building up, and a removal of waste material; and while it is essential to have a regular supply of nourishment to maintain the body, it is equally requisite that the effete or waste products be regularly and thoroughly removed. Otherwise the blood will be rendered unfit for performing its functions.

It must appear evident that the atmosphere is liable to contain many impurities, derived from the decomposition of animal and vegetable matters. These entering the blood in the process of respiration, poison it, and produce such diseases as the one under consideration. The most careful chemical analyses fail to detect them, and we recognize them only in their effects upon the blood and system in general.

Like all poisons, those producing zymotic diseases appear to be subject to certain general laws, the most important of which are, according to Dr. Aitken, (1) That they have all certain definite and specific actions; (2) That they all lie latent in the system, a certain but varying period of time before their actions are set up; and (3) That the phenomena resulting from their action vary in some degree according to the dose and the receptivity of the patient.

Zymotic poisons have been divided into three classes, viz., 1. Paludal malarious poisons; 2. Animal malarious poisons; 3. Specific disease poisons. The first do not exert their influence upon domestic animals to the same extent as upon man. They result from the decomposition of vegetable substances, and may be carried by the wind to considerable distances, giving rise to agues, rheumatic fevers, and other diseases. The second arise from the decomposition of various animal substances. The winter season, when the dwellings of man and beast are too often overcrowded and ill ventilated, is favourable to their development. The blood becomes charged with them, and they exert a depressing influence upon the system. The third or "specific disease poisons," are derived from the bodies of animals suffering from the disease; for the body once contaminated by the poison, is capable of generating it and spreading the disease to others.

Mr. McEachran here gives several extracts from Dr. Beale's book on "Disease Germs," relating more especially to the spread of infectious diseases; but we must omit them and pass on to such points as the symptoms and treatment of Epizootic Influenza, using Mr. McEachran's own words as far as possible.

As is generally known the present *epizootic* made its appearance in Toronto in the beginning of October, and there soon spread to such an extent as to completely arrest all business depending upon horses—scarcely a horse escaping. From Toronto it gradually extended in an easterly direction, until, on the 8th of October, one case was detected in this city. On the morning of that day my attention was directed to a peculiar deep cough affecting a mare belonging to a gentleman in this city. On examining her closely, I found that she presented symptoms indicative of influenza in which bronchitis was prominent. The gentleman had bought a pair of carriage horses in Ontario which were both coughing; but as they did not appear to suffer much, it was supposed to be the result of a slight cold contracted in coming from Toronto here. However, on examination, I found the same indications of influenza as in the mare.

On the following day four cases occurred in a stable in the same street; on the 10th, six more in different parts of the city; and on the 11th as many more. By the 17th scarcely a horse in the city could be said to be free from it. To give an idea of the suddenness of its spread, I may mention that in one stable which I visited on Saturday evening, there was not a single case, but when I was sent for next morning, half the horses were affected, and before night the entire stock of about fifty had the disease.

Symptoms.—The period of incubation would seem to be very short; but I think that I am right in saying that the time which the poison takes to become developed after its introduction into the system is short, say from one to three days. A peculiar deep cough early sets in, and in most cases there was a copious discharge from the nostrils. The discharge was generally thick and purulent; in a few cases it had the peculiar orange colour which we find in typhoid fever, but often it was white and curdy. As a rule, however, it was the ordinary muco-purulent discharge seen in catarrhal affections. In old horses, especially in protracted cases, blood was often mixed with it. There was occasionally also a purulent discharge from the eyes. The mucous membranes were swollen, soft, and generally of a pale buff colour, though in some old animals they had a distinctly yellow tinge, especially observable in the sclerotic coat and the lining of the eyelids—an indication of hepatic derangement. The throat in all cases was swollen, the thyroid and submaxillary glands slightly, but the mucous membrane of the fauces, posterior nares and epiglottis considerably. This occasioned difficulty in swallowing, and brought on severe fits of coughing. Quantities of thick gummy sputa were frequently coughed up from the throat, but in several cases became so adhesive that death was occasioned by its obstructing the air passages.

The typhoid form of fever was a prominent symptom. The mouth was hot, but not dry, being kept moist by the constant secretion from the throat, the pulse seldom over fifty-five to sixty, the respiration rapid and abdominal, the flanks contracted and the extremities usually cold. In mild cases the appetite continued fair, but the soreness of the throat often occasioned diffiiculty in swallowing. Debility was noticeable in a marked degree. The bowels were usually costive, but in some cases unduly relaxed.

As the disease progressed, debility increased, the appetite failed, fits of shivering came on, and a depressed line could be seen along the cartilages of the ribs; the head protruded, the nostrils were distended and the pulse quick and irregular; in fact, the symptoms of acute congestion of the lungs were presented in a marked manner. In these cases it was found best to induce superficial circulation by increasing the clothing and rubbing and bandaging the legs. A diffusible stimulant was also given by way of equalizing the circulation, and marked relief was afforded by stimulating the sides of the chest with an embrocation. If, however, the case were neglected, or improperly treated, *pleuro-pneumonia* of a typhoid type resulted. The animal then stood with the head protruded, the ears drooping and cold, the fore-legs used as props, the breathing quick and short, a depressed line from the flank to the sternum, the cough muffled, and the act of coughing painful. In many cases thoracic effusion and œdema of the legs occurred to a considerable extent. This was seen more particularly in old animals, especially in secondary attacks. In some horses there were painful nodulous swellings along the sides of the chest and belly, and often in the groin and thigh; the breath, moreover, had occasionally an intolerable odour.

Post-mortem Examinations.—Several rather hurried *post-mortem* examinations were made, and showed that the respiratory organs were diseased in a marked degree. The mucous membrane from the nostrils to the air-cells was thickened and soft, and the sub-mucus tissue, particularly at the posterior nares, thickly infiltrated. The epiglottis and laryngeal membrane were also thick and soft; and in one case the entire fauces were black and gangrenous. The lungs were black and very much congested, the right lung in one animal being completely disorganized, and the chest about a quarter filled with discolored unhealthy serum. The pleura was thickened and covered by deposits of soft easily broken down lymph of a dirty whitish-yellow colour, with no adhesions.

The digestive organs did not show signs of any special disease, with the exception of the liver, which was much congested and easily broken up. The vessels of the brain and cord were slightly congested, and the heart invariably filled with large coagula of black grumous blood. The tissues generally were soft and flaccid, and decomposition set in very shortly after death.

The blood showed the most marked signs of disease. Its colour instead of being scarlet was almost black, and the separation of the serum from the clot was very incomplete. The white corpuscles were found to be much larger and much more numerous than in healthy blood; while the red were small, irregular in outline, and not collected in meshes of the plasma. The latter, moreover, were of a very light colour. We can at once see that blood in such a condition is incapable of nourishing and purifying the tissues.

When examined with a high magnifying power, forms could be detected, of which Mr. McEachran says: "Whether these are disease germs, or the products of the action of germs still more minute, on the vital fluid and the tissues through which it passes, I am not prepared to say."

Treatment.—In diseases of this class depletion ought not to be practised. The first point to be attended to is a supply of pure air; the stables should accordingly be thoroughly ventilated and drained, and carbolic disinfectants used. The efficient action of the several emunctories should be encouraged,—in the case of the skin by cleanliness and increased clothing, in that of the bowels by laxative food, and in that of the kidneys by saline diuretics. The stable should have a temperature of about 65° F., and hot mucilaginous drinks immediately provided.

Sulphite of soda has a beneficial action upon the blood. Some of the salts of potash, especially the nitrate, have also proved useful. Chlorate of potash makes a good wash for the throat, and bromide of potassium a still better one. The throat, and also the sides of the chest, when pleuritic symptoms are prominent, should be mildly blistered. Ordinary ammoniacal liniment may be used for this purpose. The nostrils should be frequently sponged with warm water containing carbolic acid; when the discharge was glutinous and obstructed the breathing, steaming the head proved beneficial.

After the third day tonics and stimulants were required.

When, in the secondary stages, chills set in, increased clothing, rubbing and bandaging the legs, and the use of a diffusible stimulant (sesquicarbonate of ammonia, acetate of ammonia, with spirits of nitrous ether, hot beer, gin or whiskey) soon restored the balance of circulation, and the congestion and shivering fits passed off. At this stage the amount of exercise depends upon the strength of the patient and the state of the weather. So long as the animal's head is up, his attention easily attracted, and he feeds tolerably well, he will be the better of exercise in the open air. The appetite, moreover, must sometimes be coaxed, for while some horses would eat hay, others would only take soft food. Apples, carrots, potatoes, bread, boiled oats and boiled barley are the best things to offer them.

In the third or dropsical stage, free scarification, or setons under the chest, should be resorted to. Exercise, hard rubbing of the legs, and tonics,—sulphate of iron, with ginger and gentian, given morning and evening, substituting a diuretic every second morning.

While the above remedies appear to have been useful, the treatment that proved most efficacious consisted in good nursing with generous diet in an easily digested form, an abundant supply of pure air, and exercise regulated according to the capability of the patient.

GEOLOGY AND MINERALOGY.

THE MINERAL REGION OF LAKE SUPERIOR.—At the fifth monthly meeting of the Natural History Society, held on Monday evening last, Feb. 24th, Prof. R. Bell, of the Geological Survey of Canada, read a paper on the Huronian and mineral-bearing rocks of Lake Superior; an abstract of which will be found below.

In addition to the sandstones of the South shore of the Lake, which are unaltered sediments, in which traces of organic life have been detected, there are three well-marked groups of rocks on the Canadian side. These are the Laurentian, the Huronian, and the Upper Copper-bearing series of Lake Superior. Recent researches have shewn that Huronian rocks occur to a much larger extent than was formerly supposed, as bands alternating with Laurentian beds on both the North and South shores of the Lake.

To the northward of Lake Superior the Laurentian rocks for the most part consist of gray and reddish gneiss, with micaceous belts and mica schists. No minerals of any economic value have yet been found in these rocks, at this particular locality, nor do there seem to be any crystalline limestones.

In the same region the Huronian rocks are mostly of a schistose character, the most common of which are greenish schists and imperfect gneisses, the whole formation being rich in useful minerals.

A geological map, coloured in conformity with the latest discoveries, of the country lying to the north of the lake, and extending from its eastern point as far west as Lake Winnipeg, was then exhibited and explained somewhat in detail, the site of Lake Shebandowan being also pointed out. About two-thirds of this area consists of Laurentian beds, and the remainder of Huronian rocks.

In these latter deposits almost every conceivable variety of schist is to be met with. Among them are micaceous, hornblendic, dioritic, porphyritic, siliceous, cherty, chloritic, felsitic and argillaceous schists; more rarely dolomitic schists, and occasionally bands of magnetic iron ore and hæmatite. The lecturer stated that in this region gold and silver veins are always associated with dolomitic schists. The principal vein, to the southwest of Shebandowan Lake, and others, were referred to as bearing out this statement. In the Hastings series of rocks gold is also associated with dolomitic schists.

Various isolated patches of granite and syenite, some a few yards and others many miles in extent, but always connected with Huronian rocks, were pointed out on the map. In these masses there is no stratification.

In the Nipigon Basin, the Upper Copper-bearing rocks of Lake Superior attain their maximum development in Canadian territory. This area has the shape of an arrow head, with the apex pointed to the true North. The basin floor consists of marls, sandstones, &c., often covered with trappean outflows. The lecturer was disposed to think that this trappean outburst originated from some point in Lake Superior. The direction of the flow, as indicated by wrinkles on the surfaces of beds, is from the centre outwards. The occurrence of these traps on all sides of the lake, and their general arrangement, which presents an appearance as if the masses had been pressed against the rocky margin of the lake basin, are supposed to favour this view. The overflow in the Nipigon Basin, too, becomes exhausted in receding from Lake Superior.

Unlike the Laurentian rocks, in which, as before stated, no useful minerals have been found, the Huronian beds contain ores of iron, copper, lead, gold, silver and nickel. Copper is most frequent in quartz veins which intersect dioritic schists of Huronian age. The silver and gold veins near Shebandowan occur in similar schists, and were discovered by Mr. P. McKellar in the spring of 1871. A letter from Mr. McKellar to Prof. Bell was then read, which gave a description of the details. The principal vein Mr. McKellar writes, is of quartz, and is from two to six feet in thickness. In addition to gold and silver it contains ores of all the metals we have cited above as occurring in Huronian rocks. At this locality, in addition to the dolomitic band associated with intrusive granite, a great variety of Huronian schists occur. A vein of calc-spar and quartz cutting through Huronian schists on mining lot 3 A, on the North Shore of Thunder Bay, and containing native silver and nickel ore, was next described.

The main silver vein of Silver Islet belongs to the Upper

Copper-bearing series, and although it has been worked to a depth of 150 feet below the surface, no trouble has yet been experienced from flooding. Up to the middle of last summer about one million dollars' worth of silver has been taken from this mine. Various other silver-bearing veins and mines in rocks of this age were described briefly, but the space at our disposal will only allow of the bare mention of their names. Suffice it to say that the Algoma, Silver Harbor, Thunder Bay Silver mine, Shuniah, Jarvis Island, McKellar's Island and McKellar's Point deposits were each noticed. In conclusion the lecturer said that the silver veins which intersect trappean rocks belong to two sets, one of which have a N. E. and the other a N. W. direction.

At the close of the lecture a large number of specimens of the rocks of the district in question were exhibited and their peculiarities explained by Prof. Bell.

Mr. A. R. C. Selwyn brought for comparison a series of gold-bearing rocks from Australia. Some of these were evidently of Lower Silurian age, and contained graptolites, &c.

Mr. C. Robb asked whether the Silver Islet dyke had anything to do with the metalliferous character of the vein at that place.

Prof. Bell said the popular notion was that it had, but that the trials which had been made on other veins crossing the dyke did not support this view. The dyke is peculiar in its composition and contains a number of metals.

In the course of the discussion which followed, Mr. Bell suggested that if it were desirable to have a shorter name for the Upper Copper-bearing series of Lake Superior, we might adopt that of the Nipigon Group.—J. F. W.—(*Montreal Gazette.*)

Native Iron Discovered by Nordenskiöld in Greenland.—The masses of native iron discovered in 1870 by Nordenskiöld at Ovifak in Greenland are especially interesting; for while on the one hand their mode of occurrence would lead one to consider them as terrestrial, their chemical constitution, though on the whole different from that of ordinary meteoric iron, in some respects, comes so near to it as to give some ground for considering them as extra-terrestrial. Specimens have been examined by Nordenskiöld, Wöhler, Daubrée and Berthelot.

The following is an abstract in a recent number of the Journal of the Chemical Society of a paper on the subject by A. Daubrée (Compt. rend., lxxiv, 1543–1550):

"In 1870 Nordenskiöld discovered at Ovifak, in Greeland, fifteen huge masses of native iron, of which one block, calculated to weigh at least 20,000 kilograms, is supposed to be the largest specimen of native iron on record. The whole were found within an area of 50 square meters. A basaltic rock, in close proximity to the masses, contained many fragments of metallic iron, and the detached blocks were also partially encrusted with a rock of similar character; there would appear to be no doubt but that the iron in the two situations was of identical origin.

"Nordenskiöld submitted portions of the iron to analysis, and found it to contain both nickel and cobalt: from this circumstance he concluded that it was of extra-terrestrial origin. Wohler, who also examined it, was of the same opinion. It must be admitted, however, that the intimate association of the iron with large eruptive masses in the neighbourhood tends to throw considerable doubt upon the accuracy of these conclusions. Several large specimens of iron from both sources were presented to the author, one of which he has carefully examined.

"This specimen was of a deep grey colour, almost black, resembling magnetite or graphitic cast-iron. It had a distinct cleavage, but the faces were not regular, and no distinct crystalline system could be seen. It was not ductile, but broke under the hammer, giving a dark brown-red powder, which was strongly attracted by the magnet. On a polished surface a want of uniformity in structure was observable, the brilliant white crystals of schreibersite and brass-yellow crystals of troilite being distinctly visible. At other places the presence of silicates produced deep green lithoïdal patches upon the surface. When treated with cold water the powder yielded a small percentage of sulphate and chloride of calcium with a trace of ferric chloride; in this respect the present specimen differs from an ordinary meteorite, in which the occurrence of calcium chloride has not been previously observed.

"The following are the results of a complete analysis:—

Iron, metallic	40·94
Iron, combined with O, S, and P	30·15
Carbon, combined	3·00
Carbon, free	1·64
Nickel	2·65
Cobalt	0·91
Oxygen	12·10
As, S, P, Si, Cu, H_2O, &c.	8·61
	100·00

"At the author's request Berthelot examined the same sample. He found that on ignition it gave off a certain quantity of carbon monoxide and dioxide, but that no gaseous hydrocarbons were evolved. He also carefully examined it for graphite, but found none."

"These masses of iron from Ovifak are remarkable, not only from their large dimensions, but also from their chemical constitution, in which latter point, as well as in other physical characters, they are totally distinct from the general type of meteorites as at present known. The sharpness of the crystals of the silicates contrasts strongly with the confused crystallisation common in meteorites, to such an extent indeed that it is even possible to detect the cleavage and crystalline form characteristic of certain felspars, and by the aid of the microscope and polarized light to recognize an arrangement of the crystals such as is seen in labradorite ahd some varieties of dolerite. Again, the large quantity of soluble salts and calcium sulphate is another distinctive character, as is also the fact that, although in meteorites, the iron is frequently combined with sulphur, phosporus, &c., it is rarely if ever combined directly with oxygen, which latter is, in the present instance, the principal form of combination of the iron. This circumstance, as well as the presence of carbon, both free and combined, allies these specimens to the minerals known as carbonaceous meteorites.

"On the other hand, they differ still more widely from terrestrial species, such as dolerites and basalts, more especially since they contain nickel, cobalt, and ferrous sulphide.

"The author is inclined to think that these masses of iron are not of meteoric origin, but that they have been formed from basaltic rock, and erupted from exceptionally great depths. These basaltic rocks frequently contain as much as 20 per cent. of ferric oxide, and it is not impossible that during their passage to the surface, this oxide may have been partially reduced to the metallic state; at all events, such a supposition would account for most of the phenomena observed. This reduction would be especially probable in Greenland, where large deposits of lignite occur, and the presence of carbon in the masses might perhaps be accounted for in a similar manner. Against this must be set the fact that these specimens contain matter which decomposes or volatilises at a very moderate heat, which would be incompatible with their passing through such a highly heated region, as the presence of crystallised and anhydrous silicates would seem to imply.

"It has been noticed by Stammer and others that carbonic oxide, in presence of iron or iron oxide, produces, under certain circumstances, a deposit of carbon, of which a certain portion combines directly with the iron.

"This reaction the author has endeavoured to utilise as a synthetical method, not so much with the intention of preparing artificial meteorites, as to be enabled, by studying the phenomena which occur, to explain perhaps more satisfactorily the circumstances which attend the natural formation of masses of native iron."

BOTANY AND ZOOLOGY.

Genera Lichenum: An Arrangement of the North American Lichens. By Edward Tuckerman, M.A., Professor of Botany in Amherst College. Amherst, 1872.—Many of our most industrious botanists have neglected the lower forms of plant life. Possibly this is as much the result of the want of sufficient books of reference and of authentic collections, easily accessible, as of the greater patience and discrimination required in studying the lower organisms. Notably the Lichens have failed to excite enthusiasm: and yet how common and how conspicuous many of them are! The bare rock where no other life could thrive is often decked with variously coloured Lichens: on the ground amid the moss and on the old decaying stumps which too often stud the Canadian fields they are met with: our old palings have their coatings of them, dry and crisp; and parasitic-like they roughen the bark of almost every tree. Fortunately for science in America they have not been altogether overlooked. We have long known that Professor Tuckerman, of Amherst College, has made them a subject of special study, and to him botanists from various parts of North America have sent their collections for determination or criticism. Anything from his pen is sure to evince great care and unsparing labour, and the volume before us, the result of long and patient study of these collections, is no exception. In the preface he in brief tells us that the work is "a final report to the friendly correspondents of the author on the specimens which for many years they have sent to him for determination; and such determination implying a certain arrangement, the book is a further report upon what, after much labour, has commended itself to him as the best ascertained systematic disposition of the Lichens."

The value of spores in the determination of genera and species is now well known, though minor distinctions depending on size, septation, and the number of spores in each spore-case have by some authors been allowed too much weight. Professor Tuckerman's views on this subject, which first appeared in a pamphlet published in 1866, on Lichens of California, Oregon and the Rocky Mountains, are that "analysis scarcely indicates more than two well defined kinds of Lichen spores, complimented, in the highest tribe only, by a well defined intermediate one. In one of these (typically colourless) the originally simple spore, passing through a series of modifications, always in one direction and tending constantly to elongation, affords at length the *acicular* type. To this is opposed (most frequently, but not exclusively in the lower tribes, and even possibly anticipated by the polar bilocular sub-type in *Parmeliacei*) a second (typically coloured) in which the simple spore, completing another series of changes, tending rather te distention and to division in more than one direction, exhibits finally the *muriform* type." A consideration of these spore and other distinctions has led to considerable changes in the grouping of the species. A critical reference to these would interest the working lichenologist rather than the general student, and in this place we therefore need not more than say that the whole of these little organisms are, in the work before us, divided into five tribes whose characters are dependent chiefly on the external structure of the apothecium. These are sub-divided into families under which the genera are arranged. Beyond this, it will be sufficient to instance the changes in two familiar genera—the *Parmelia* of the old books, which is separated into *Theloschistes*, *Parmelia* and *Physcia*: and *Lecanora* which now becomes *Placodium*, *Lecanora* and *Rinodina*.

The book is replete with elaborate critical notes on the tribes, families, genera and species; several new species, some of which are of interest to Canadians as occurring here, are incidentally described or referred to; and what is of value in connection with the subject of geographical distribution, the range of species on this continent is frequently indicated.

Prof. Tuckerman's labours have been purely scientific. There is not perhaps very much in the book to attract the general scientific reader, but among those who make the Lichens their study this volume will be much appreciated.—A. T. D.

LARVÆ OF WORMS AND ECHINODERMS.—In a recent memoir in the Transactions of the American Academy, Alexander Agassiz, shews that certain larvæ named *Tornaria*, supposed to belong to star-fishes, are really young worms of the genus *Balanoglossus*. This, in his judgment, tends to destroy the slender basis of embryological resemblance on which Huxley had endeavoured to separate Echinoderms from other radiates and place them with certain worms in the so-called sub-kingdom Annuloida. If this is really so, it will tend to remove a perplexing anomaly of classification which has already found its way into many text books of Zoology and Palæontology.

CHEMISTRY.

Rubidium in Beetroot.—The average composition of the ash obtained from the beetroots of the North of France is the following:

Potassium carbonate	30 per cent.
Sodium carbonate	20 " "
Potassium chloride	18 " "
Potassium sulphate	9 " "
Insoluble matter and moisture	23 " "

Besides these substances, small quantities of iodine and bromine, and of rubidium, are contained in the ash. The above substances may be separated by crystallization, or the potassium salts may be utilized first by converting them into the chloride and then into nitrate, by addition of sodium nitrate. After the separation of the greater portion of these salts by evaporation, &c., the rubidium may be precipitated from the diluted mother-liquor by addition of dilute solution of platinic chloride, or better by addition of a hot saturated solution of a potassio-platinic chloride. The precipitate obtained may be freed from the potassium salt by washing with water, and then reduced in a current of hydrogen. The author (E. Pfeiffer) estimates that ash from the beetroot of the North of France contains about 1.75 grm. of rubidium chloride to the kilogram of ash. From this it follows that 1 hectare of land yields about 255 grains of rubidium chloride to every crop of beetroot. The rubidium chloride contained a trace of caesium, but no lithium was found in the ash. Tobacco from the same region contains potassium, rubidium, and lithium and traces of sodium, whilst rape-seed contains only potassium and sodium, but neither rubidium nor lithium.—*Abstract in Jour. " Chem. Soc."*

Gold in Sea-water.—According to E. Sonstadt, the presence of gold in sea-water can readily be detected by several methods, although occuring in the very minute proportion of less than one grain to the ton. The solution of the gold is due to the presence of iodine, which, as Sonstadt showed some time ago, is liberated from the iodate of calcium existing in sea-water by the action of putrescible organic matter. The methods employed, by Sonstadt for the detection of the gold are exceedingly interesting and ingenious. According to the first method, he operates upon 150 or 200 cubic centimetres of water. Two or three decigrammes of ferrous sulphate are dissolved in the water, which is made acid by the addition of two or three drops of hydrochloric acid. The solution is then heated in a glazed porcelain dish over *a small flame, which is so arranged as to touch the* under part of the dish, but should not produce ebullition. By this means a lustrous film of ferric oxide is deposited upon the bottom of the dish. The heat is kept up as long as the film increases, and the remaining liquid then poured off, the film washed with a little water, and 50 c. c. of strong chlorine water allowed to stand in the dish for an hour or two, and then evaporated down to a few drops, a drop of dilute hydrochloric acid being added towards the close of the evaporation. The liquid, which should be nearly colourless, is now poured into a test-tube containing a few drops of a solution of stannous chloride, and after a few minutes the liquid takes a bluish or purplish tint. The reaction is of course more distinct when larger quantities of water are used. Sonstadt says that he has sometimes failed to obtain the film of ferric oxide, but has been most successful when after the addition of the ferrous sulphate and hydrochloric acid to the water he has allowed the solution to stand for some hours exposed to the air.

In his second method he takes from half a litre to a litre of sea-water, and after adding sufficient barium chloride to produce about a grain of precipitate, allows the whole to stand for a day or two. *The precipitate is then collected, dried, and after mixing* with borax and lead, treated before the blow-pipe on charcoal and finally cupelled. In this way a yellowish-white button is obtained, having about the colour of an alloy of 60 parts of gold and 40 of silver. For the sake of confirmation, the button may be dissolved in a few drops of aqua regia and the solution evaporated nearly to dryness. A few drops of hydrochloric acid are now added, and the solution again evaporated in order to destroy the excess of nitric acid. When nearly to dryness a few drops of water are added, the mixture warmed, and, as soon as the argentic chloride has settled, a drop of solution of stannous chloride allowed to run down the side of the tube into the liquid, when the characteristic gold reaction is obtained.

The precipitation of the gold by barium chloride is curious, and explicable according to Sonstadt only "by supposing the gold to be present in the sea-water as an aurate, so as to be thrown down as aurate of barium. This view has much in its favour, and is greatly supported by the fact that if oxalic acid is added to sea-water some time before the addition of chloride of barium it is scarcely possible to detect gold in the precipitate formed. And this is easily to be understood, since oxalic acid reduces all gold salts."

Sonstadt even goes so far as saying that it is conceivable that the method of precipitation with barium chloride might be employed upon the large scale, by receiving the water at high-tide in large tanks and adding solution of barium chloride, the precipitate being removed from time to time, during low-tide.

The third method described by Sonstadt consists in the addition of a few grammes of ferrous sulphate to a litre of sea-water, this being followed in a few days by the addition of solutions of stannous and mercuric chlorides. Mercury is thus precipitated, and as it subsides carries down the gold and silver in the form of an amalgam. "This method is open to objection, as being more troublesome than the preceding methods." For further details the reader is referred to the original article in the *Chemical News*.

OBITUARY.

ADAM SEDGWICK.

Geology has lost her veteran leader! While yet firm in intellect, full of kind and generous feeling, and occupied on the last pages of the latest record of his labours, in the ninth decade of a noble life, Sedgwick has gone to his rest. Under the shadow of this great loss we look back through more than half a century, and behold no more conspicuous figure in the front ranks of advancing geology than the strenuous master workman, the eloquent teacher, the chivalrous advocate of science, who has now finished his task. Severe illness, borne with fortitude, had gradually withdrawn him from scenes once brightened by his ever-welcome presence, but could not tame the high spirit, or cloud the genial sympathies which had won for him, more than for other men, the loving admiration of his fellows in age and followers in study. Rarely has a patriarchal life been crowned with such enduring and affectionate respect.

Born in 1785, of a family long resident in a secluded Yorkshire Valley under the shadow of Wharnside, the boy early acquired the hardy habits and imbibed the free spirit of the north, and the man retained till his latest hour, a romantic love of the bold hills and rushing streams, amidst which he first became an observer of nature. Every homestead and every family in his native dale of Dent were treasured in his memory, and one of the latest of his minor literary essays was to plead against the change of the ancient name of a little hamlet situated not far from his birth-place.

Educated under Dawson, at the well-known school of Sedbergh, while Gough and Dalton were residing at Kendal, he proceeded to the great college in Cambridge, to which Whewell, Peacock, and Airy afterwards contributed so much renown. Devoted to the Newtonian philosophy, and especially attracted by discoveries then opening in all directions in physical science, he stood in the list as fifth wrangler, a point from which many eminent men have taken a successful spring. He took his degree in 1808, became a fellow in 1809, was ordained in 1817, and for some years occupied himself in the studies and duties of academic life. His attention to geology was speedily awakened, and became by degrees a ruling motive for the long excursions, mostly on horseback, which the state of his health rendered necessary in the vacations.

It was not, however, so much his actual acquirements in geology as the rare energy of his mind, and the habit of large thought and expanding views on natural phænomena, that marked him out as the fittest man in Cambridge to occupy the Woodwardian chair vacated by Hailstone. Special knowledge of rocks and fossils was not so much required as a well-trained and courageous intellect, equal to encounter theoretical difficulties and theological obstacles which then impeded the advance of geology.

The writer well remembers, at an evening *conversazione* at Sir Joseph Banks's, to which, as a satellite of Smith, he was admitted at eighteen years of age, hearing the remark that the new professor of geology at Cambridge promised to master what he was appointed to teach, and was esteemed likely to do so effectually. In the same year Buckland, his friendly rival for forty years, received his appointment at Oxford, where he had previously began to signalize himself by original researches in palæontology.

At this time the importance of organic remains in geological reasoning, as taught by Smith, was not much felt in Cambridge, where a new born mathematical power opened out into various lines of physical research, and encouraged a more scientific aspect of mineralogy, and a tendency to consider the phænomena of earth-structure in the light of mechanical philosophy. This is very apparent in the early volumes of the Cambridge Philosophical Society, established in 1819, with Sedgwick and Lee for secretaries. Accordingly, the earliest memoirs of Sedgwick, which appear in the Cambridge Transactions for 1820–21, are devoted to unravel the complicated phænomena of the granite, killas, and serpentine in Cornwall and Devon; and to these followed notices of the trap-dykes of Yorkshire and Durham, 1822, and the stratified and irruptive greenstones of High Teesdale, 1823–24. In his frequent excursions to the north he was much interested in the varying mineral characters and fossils of the magnesian limestone, and the remarkable nonconformity of this rock to the subjacent coal, millstone grit, and mountain limestone; and at length his observations became the basis of that large systematic memoir which is one of the most valuable of the early contributions to the Transactions of the Geological Society. Begun in 1822 and finished in 1828, this essay not only cleared the way to a more exact study of the coal formation and New Red sandstones of England, but connected them by just inference with the corresponding deposits in North Germany, which he visited for the purpose of comparison in 1829.

To one of the equestrian excursions the writer was indebted for his first introduction to Sedgwick. In the year 1822 I was walking across Durham and North Yorkshire into Westmoreland. It was hot summer-time, and after sketching the High Force, in Teesdale, I was reclining in the shade, reading some easily carried book. There came riding up, from Middleton, a dark-visaged, conspicuous man, with a miner's boy behind. Opposite me he stopped, and courteously asked if I had looked at the celebrated waterfall which was near; adding that though he had previously visited Teesdale, he had not found an occasion for viewing it; that he would like to stop then and there to do so, but for the boy behind him, "who had him in tow to take him to Cronkley Scar," a high dark hill right ahead, where, he said, "the limestone was turned into lump-sugar."

A few days afterwards, on his way to the lakes, he rested for a few hours at Kirby Lonsdale to converse with Smith, who was engaged on his geological map of the district, and had just discovered some interesting fossils in the laminated strata below the Old Red sandstone, on Kirkby Moor, perhaps the earliest observation of shells in what were afterwards called the upper Ludlow beds. The two men thus brought together were much different, yet in one respect alike: alike in a certain manly simplicity, and unselfish communion of thought. Eight years after this Adam Sedgwick was President of the Geological Society, and in that capacity presented to William Smith the first Wollaston medal. The writer may be permitted the pleasure of this reminiscence, since from the day when he learned the name of the horseman in Teesdale, till within a few days of his death, he had the happiness of enjoying his intimate friendship.

Sedgwick had acquired fame before Murchison began his great career. After sharing in Peninsular wars, and chasing the fox in Yorkshire, the "old soldier" became a young geologist, and for many years worked with admirable devotion to his chief, and carried his banner through Scotland, and Germany, and across the Alps, with the same spirit as he had shown when bearing the colours for Wellington at Vimiera.

Important communications on Arran and the north of Scotland, including Caithness (1828) and the Moray Firth, others on Gosau and the eastern Alps (1829–1831), and still later, in 1837, a great memoir on the Palæozoic Strata of Devonshire and Cornwall, and another on the coeval rocks of Belgium and North Germany, show the labours of these intimate friends combined in the happiest way—the broad generalisations in which the Cambridge Professor delighted, well supported by the indefatigable industry of his zealous companion.

The most important work in the lives of these two eminent men was performed in and around the principality of Wales; Sedgwick, as might be expected, lavishing all his energies in a contest with the disturbed strata, the perplexing dykes, and the cleavage of the lowest and least understood groups of rocks; Murchison choosing the upper deposits exceptionally rich in fossils, and on the whole presenting but little perplexity as to succession and character. One explorer, toiling upward from the base, the other descending from the top, they came after some years of labour (1831 to 1835) in sight of each other, and presented to the British Association meeting in Dublin a general view of the stratified rocks of Wales.

Thus were painfully unfolded the Cambrian and Silurian systems, which speedily became, in a sense, the scientific property of the discoverers, and were supposed to be firmly separated by natural and unmistakeable boundaries. They were, however, not really traced to their junction, though Murchison stated that he had found many distinct passages from the lowest member of the Silurian system into the underlying slaty rocks named by Prof. Sedgwick the "Upper Cambrian;" while Sedgwick admitted that his upper Cambrian, occupying the Berwyns, was connected with the Llandeilo flags of the Silurian system, and thence expanded through a considerable portion of South Wales (Reports of Brit. Assoc., 1835). The Bala rocks were disclaimed on a cursory view by Murchison, the Llandeilo beds surrendered without sufficient examination by Sedgwick; thus the two kingdoms overlapped largely; two classifications gradually appeared; the grand volume of Murchison was issued; and then began by degrees a difference of opinion which finally assumed a controversial aspect, always to be deplored between two of the most truly attached and mutually helpful cultivators of geological science in England:—

"Ambo animis, ambo insignes præstantibus armis."

This source of lasting sorrow to both, if it cannot be forgotten, ought to be only remembered with the tenderness of regret.

Familiar as we now are with the rich fauna of the Cambrian and Silurian rocks, and their equivalents in Bohemia and America, it is not difficult to understand, and we may almost feel again the sustained enthusiasm which welcomed the discoveries which seemed to reveal the first state of the sea, and the earliest series of marine life "primaque ab origine mundi," almost to complete the physical history of the earth. Starting with a general view of the structure of the Lake Mountains of the north of England, and the great dislocations by which they have been separated from the neighbouring chains (Geol. Proc. Jan. 1831). Sedgwick won his difficult way through North Wales to a general synopsis of the series of stratified rocks below the Old Red sandstone, and attempted to determine the natural groups and formations (Geol. Proc. May, 1838). Three systems were named in order—Lower Cambrian, Upper Cambrian, Silurian—the working out of which, stream by stream, and hill by hill, worthily tasked the energies of Ramsay and his friends of the National Survey for many useful years, after increasing ill-health had much reduced the field-work of the Professor.

But now he began to labour more earnestly than ever in the enlargement and setting in order of the collections which were under his personal charge. In 1818, these consisted almost wholly of the small series bequeathed by Dr. Woodward; now they have been expanded by the perpetual attention and generosity of Sedgwick, into one of the grandest collections of well-arranged rocks and fossils in the world. One of the latest acquisitions is the fine cabinet of Yorkshire fossils, purchased by Cambridge as a mark of loving respect for her great teacher in his fast decaying days.

In this work of setting in order a vast collection gathered from various regions, and from all classes of deposits, Prof. Sedgwick, with wise liberality, engaged the willing aid of some of his own pupils, and of other powerful hands brought to Cambridge for the purpose. Ansted, Barrett, Seely, M'Coy, Salter, Morris, have all helped in this good work, and to their diligence and acumen were added the unrivalled skill and patience of Keeping, one of the best "fossilists" in Europe. Those who in this manner have concurred in the labours of their chief, one and all found in him the kindest of friends, the most considerate of masters—one who never exacted from others, and always gave to his assistants more than the praise and the delicate attention which their services deserved.

The ample volumes entitled "British Palæozoic Rocks and Fossils, 1851–5," by Sedgwick and M'Coy, must be consulted for a complete view of the classification finally adopted by Sedgwick; and further information is expected from the publication of a Synoptic Catalogue, to which Salter gave some of his latest aid.

During his long tenure of a Fellowship in Trinity College, Prof. Sedgwick witnessed great changes in the mathematical training, and contributed as much as any man to the present favourable condition of Science in Cambridge.

To defend the University against hasty imputations, to maintain a high standard of moral philosophy, and a dignified preference for logical induction to alluring hypothesis was always in his thoughts. Hence the "Discourse on the Studies of the University of Cambridge," at first an eloquent sermon, grew by prefix and suffix to a volume which he himself likened to a wasp—large in front and large behind, with a very fashionable waist.

Under such feelings he spoke out against the "Vestiges of

Creation" with a fervour of argument and declamation which must have astonished the unacknowledged author of that once popular speculation. Nor was he silent when the views of Darwin came to fill the void places of biological theory, against which he not only used a pen of steel but made great use of his heavy hammer.

The vigour—vehemence we may call it—of his pen and tongue in a matter which touched his sense of justice, morals, or religion, might mislead one who did not thoroughly know his truth and gentleness of heart, to suppose that anger was mixed with his honest indignation; but it was quite otherwise. In a letter addressed to the writer, in reply to some suggestion of the kind, he gave the assurance that he was resolved "no ill blood" should be caused by the discussion which had become inevitable.

He never failed in courtesy to the honest disputant whose arguments he mercilessly "contunded." Taken altogether, Professor Sedgwick was a man of grand proportion, cast in a heroic mould. Pressed in early life through a strict course of study, he found himself stronger by that training than most of his fellow geologists, but never made them feel his superiority. Familiar with great principles, and tenacious of settled truths, he was ready to welcome and encourage every new idea which appeared to be based on facts truly observed, and not unprepared or unwilling to stand, even if alone, against what he deemed unfair objection or unsubstantial hypothesis.

This is not the place to speak of his private worth, or to indulge in reminiscence of his playful and exuberant fancy, the source of unfailing delight to those who knew him in his happier hours. Unmarried, but surrounded by plenty of cheerful relatives, his last hours of illness were soothed by sedulous affection; his kindly disposition no suffering could conceal; his lively interest in passing events nothing could weaken. Ever

"Against oppression, fraud, or wrong,
His voice rose high, his hand waxed strong."

With collected mind, on the verge of the grave, he would express, with undiminished interest, his latest conclusions on his own Cambrian system, purely as a matter of scientific discussion, free from all personal considerations. It will be well if this mode of treatment be reverently followed by those who while speaking of Protozoic and Palæozoic Rocks, know enough to feel how much they have been benefited by the disinterested labours of a long and noble life.—*From "Nature."*