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ON THE GEOLOGICAL RELATIONS OF THE IRON ORES OF NOVA SCOTIA.

(Read before the American Association for the Advancement of Science.)

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The Iron Ores of Nova Scotia, long neglected, have recently begun to attract the attention of capitalists to an extent in some degree commensurate with their importance. The magnitude and variety of the deposits, the great richness of the ores, their proximity to the Atlantic and to great deposits of coal, are all features which give them very great economic value, and must eventually cause them to take no small part in contributing to the iron supply of the world. My purpose in the present paper is, with the aid of recent researches in which I have been occupied, to give a concise summary of the geological position and mode of occurrence of the principal deposits, and more especially of those facts which have been developed since the publication of my "Acadian Geology."

If we arrange these deposits in the first place under the two heads of *Beds* conformable to the stratification and *Veins*, we shall find that the former occupy three distinct geological horizons—that of the Lower Helderberg or Ludlow in the upper part of the Silurian, that of the Oriskany at the base of the Devonian, and that of the Lower and Middle Carboniferous. The latter occur in altered rocks which may be assumed to be of

Silurian age, in the Lower Carboniferous, and at the junction of these two groups of rocks. We may shortly consider the deposits of these several kinds and ages in their order.

1. Bedded Ores.

(1) *Great Hematite Bed of the Lower Helderberg Series.*

This, in so far as at present known, is most extensively developed in the vicinity of the East Branch of the East River of Pictou, and on the upper part of Sutherland's River. Here the rocks which rise unconformably from beneath the Carboniferous beds of the Pictou coal-field, consist in great part of gray and olive slates, usually coarse and unevenly bedded; and with occasional calcareous bands, holding the characteristic fossils of the "Arisaig group," a series in Nova Scotia equivalent to the Lower Helderberg of American geologists, though in its specific forms more nearly allied to the English Ludlow than to groups of this age on the great inland plateau of America. These beds are affected with slaty cleavages, highly inclined, much faulted, and folded in abrupt anticlinals, so that their detailed arrangement has not yet been satisfactorily traced. The great ore-band which forms one of the most conspicuous marks for unravelling their complexities, has been traced mainly along two distinct lines of outcrop, both somewhat curved and broken, and which seem to lie on the opposite sides of an anticlinal axis. It has also been recognized in two other localities where it must come up on distinct lines of outcrop, the precise relation of which to the others has not yet been ascertained.

The ore bed is accompanied by a thick band of olivaceous slates, and beneath this there appears hard ferruginous quartzite which Dr. Honeyman compares to the Medina sandstone. Lower than this and possibly unconformable to it are black and greenish slates with bands of quartzite and soft chloritic and nacreous schists which as yet have afforded no fossils. They are associated with hard beds or masses of rock rising into some of the highest eminences, and which have usually been described as trap, but which seem to consist for the most part of an indurated slaty breccia or conglomerate, corresponding very nearly in character to the typical graywacke of the older German geologists. These rocks may be of middle Silurian age, though possibly in part older, and we shall meet with them again in connection with the great vein of specular iron.

The ore-bed where most largely developed attains a thickness of about thirty feet, and in places where it has been opened up by exploratory works, it has been found to afford from ten to twenty feet in thickness of good ore. This ore is a red hematite, sometimes compact and laminated, but more frequently of an oolitic character occasioned by the arrangement of the peroxide of iron in minute concretions enveloping grains of sand. By the increase of these silicious grains it passes in the poorer portions into a sort of ferruginous sandstone. Similar beds of fossiliferous ore are well known to occur in the Clinton group of New York and Pennsylvania, and Prof. Hall informs me that they are found also in the Lower Helderberg series of New York.

Along the different lines of outcrop above referred to, this bed has been traced for several miles, and being of a hard and resisting character, it rises into some of the higher elevations of the country. Though not one of the richest ores of the district, its great quantity and accessibility render it highly important for practical purposes. The analyses made of it show a percentage of metal varying from 43 to 54 per cent. The foreign matter is principally Silica, and the proportions of Phosphorus and Sulphur are small—one of the specimens analyzed affording none whatever, another .22 Phosphoric Acid and .29 Sulphur. These analyses were made at the instance of Mr. E. A. Prentice, now organizing a company to work this and other deposits in the district. The principal exposures of this bed are distant only twelve miles from the great collieries of the East River of Pictou, and less than ten miles from the Pictou and Halifax Railway. This deposit was first described by Mr. R. Brown in Haliburton's History of Nova Scotia, 1829, and subsequently by the writer in Acadian Geology. More recently exploratory works have been carried on and a practical report made by Mr. G. M. Dawson, Associate of the School of Mines, London; and the bed has been traced and collections of its fossils made by Mr. D. Fraser of Springville.

(2) *Hematite and Magnetic Iron of Nictaux and Moose River.*

This deposit takes us to the other extremity of Nova Scotia, and brings us a stage higher in geological time, or to the period of the Oriskany Sandstone. It would indeed appear that the conditions of ore-deposit so marked in Eastern Nova Scotia in the upper Silurian, were continued in the western part of the Province into the Devonian. In many specimens of the Nictaux ore the chief apparent difference as compared with that of Pictou is in the contained species of fossils.

Where I have examined this bed, it appears to be six feet thick and enclosed in slaty rocks not dissimilar from those associated with the Silurian ore of Pictou. Recent explorations at Nictaux are said to have developed extensions of this deposit; but I have no details of these. As rocks of the Arisaig group are known to underlie the Nictaux beds, it is not impossible that additional beds of ore may be found in these. The normal condition of the iron of the Nictaux bed is that of peroxide; but locally it has lost a portion of its oxygen and has become magnetic. This I believe to be a consequence of local metamorphism connected with the immense granite dikes which traverse the Devonian rocks of this region.

The Nictaux ore is more highly fossiliferous than that of Pictou, and contains a larger proportion of Phosphate of Lime. In the attempts hitherto made to work this ore, the distance from coal has been a main disadvantage, but the construction of the Windsor and Annapolis railway has diminished this. The Devonian beds holding this bed are described in "Acadian Geology." An analysis of a specimen made many years ago gave 55 per cent of iron.

(3) *Bedded Ores of the Carboniferous System.*

The most remarkable of these is a bed of crystalline *Spathic iron* or Siderite, occurring in the Lower Carboniferous series, near Sutherland's River in the County of Picton. As described by Mr. G. M. Dawson, who prosecuted works of exploration in it last year, it is a conformable bed, occurring in the Lower Carboniferous red sandstones, and varying from six feet six inches to ten feet six inches in thickness. It is accompanied with smaller bands of the same mineral, and at no great vertical distance from it is a bed of gypsum. Its mode of occurrence is on the whole not dissimilar from that of the non fossiliferous sub-crystalline limestones which occur in some parts of the Lower Carboniferous series associated with the gypsum. This ore is a true Spathic Iron, granular and crystalline in texture, and when unweathered of a light gray colour. It affords from 42 to 43 per cent. of iron and contains from 2 to 8 per cent. of manganese. This bed is only four miles distant from the "Vale" colliery, and is intended to be worked in association with the Hematite already described, and with the other ores on the East River of Pictou possessed by the same proprietors. From the Report of Mr. Andrews on the second geological district of Ohio, it would appear that similar beds, though on a smaller scale, occur in the Lower Carboniferous series of that State. In Nova Scotia this bed is at present altogether unique.

Clay Ironstones occur in many parts of the Nova Scotia coal-field. In the workings of the main seam of the Albion Mines, Pictou, considerable quantities of nodular black ironstone are extracted, and will, no doubt, be utilized. In the beds under the main seam there are also clays rich in ironstone concretions. Beds with ironstone balls also occur in the measures north of the New Glasgow conglomerate, and one of these is remarkable for the fact that the nodules were found by Dr. Harrington to contain nuclei of Blende, a mineral otherwise unknown in the carboniferous of Nova Scotia. No attention has yet been given to these ores as sources of iron, but it may be anticipated that a demand for them will arise in connection with the richer ores in the older formations.

II. Veins of Iron Ore.

(1) *Great Specular Iron Veins of the Silurian Slates and Quartzites.*

In a paper on the metamorphic and metalliferous rocks of Eastern Nova Scotia in 1848,* I mentioned the fact that the inland series of metamorphic rocks (bounding the coast series now known as the gold-bearing series) and believed to be of Upper or Middle Silurian age, abound in veins of specular iron, associated with spathic iron and ferruginous dolomite, and occasionally with metallic sulphides, and I described some of these deposits. In the country eastward of Lochaber Lake, where this same formation occurs, not only are numerous small veins of specular iron and carbonate of iron found in it, but a rich vein of Copper Pyrites, noticed in "Acadian Geology," has recently been opened up and found to be very valuable.

In most parts of the region these iron veins, though very numerous, are of trifling thickness; but in two localities they are known to attain to gigantic dimensions, rendering them of great economic importance.

* Journal of Geological Society of London.

The earliest known of these was the great vein of the Acadia mine in the Cobequid mountains, discovered by the late Mr. G. Duncan, and on which I reported in 1845. These hills consist on their southern side of parallel bands of olive and black slate with beds of quartzite, all very highly inclined. The iron vein is a great irregular fissure, extending for many miles parallel to the bedding, and apparently accompanying a band of quartzite. It contains in addition to crystalline and often micaceous Specular iron and Magnetic iron, large quantities of a rich earthy red ore, which from the crystalline planes which it presents, would seem to have been a Carbonate of Iron decomposed and oxidised. These iron ores are associated with large quantities of a crystalline ferruginous Dolomite, allied in composition to Ankerite. This may be regarded as the veinstone to which the iron ores are subordinate, and which in the thinner parts of the vein occupies nearly its whole breadth. At the outcrop of the vein it is in some places weathered to a great depth into a soft and very pure yellow ochre. Small quantities of sulphides of iron and copper and of sulphate of barium are occasionally present. In addition to the above, which may be regarded as the primary contents of the vein, there occur in some parts of it secondary deposits of concretionary Limonite, which have of late years afforded a very large part of the ore smelted by the Acadia Company.

In some places the thickness of this vein has been found to be 150 feet, with intercalated masses of rock, but it is very irregular, diminishing occasionally to mere strings of ankerite. It is remarkable that in the Cobequid mountains, which are cut by transverse ravines to the depth of about 300 feet, the vein does not appear to be well developed in the bottom of the ravines, but only in the intervening heights At first I was disposed to account for this by supposing that the deposit is wedge-shaped, diminishing downward; but I have more recently been inclined to believe that the large development of the vein is dependent on differences in the containing rocks which have rendered them harder and more resisting at the points of such greater developments.

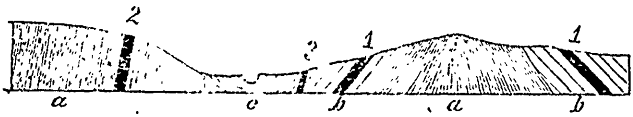
With respect to the age of these beds, they must be older than the Lower Helderberg rocks, which both at the eastern end of the Cobequids and at the East River of Pictou, rest upon them. They are on the other hand probably newer than the auriferous primordial rocks of the Atlantic coast. As they have afforded no fossils their age does not at present seem capable of more precise definition. With regard to the filling of the vein fissures, this, if coeval with the metamorphism of the containing beds or immediately subsequent thereto, would fall between the period of the lower Devonian and that of the lower Carboniferous, or within the Devonian age. The denudation connected with the Lower Carboniferous conglomerates and the fragments contained in these conglomerates, seem to imply that the ore-bearing slates were then in the same condition as at present. On the other hand the Lower Carboniferous sandstones themselves contain in places narrow veins of specular iron, which also occurs, as well as magnetic iron, in the fissures of the Triassic trap.

On the west side of the East River of Pictou, there occur rocks precisely similar to those of the Cobequid range, of which indeed they may be regarded as an Eastern continuation, and including an iron vein which must be regarded as the equivalent of that of the Acadia Mine, which it resembles perfectly in mineral character and mode of occurrence, differing only in the greater proportionate prevalence of the specular ore.*

In New Lairg, a few miles from Glengarry Station, the most western portion of this vein known to me, contains much Ankerite, with strings of Specular iron; and in large loose pieces there are indications also of red ore which is not visible in place. Farther to the eastward on the West Branch of the East River of Pictou, there appears a band of quartzite thirty feet thick filled with veins of Limonite; but specular ore is not found at this place. Still farther to the eastward and near the east branch of the East River the specular vein attains a very large development, shewing in some places a thickness of twenty feet of pure ore. Its course is S. 60° to 70° E. or nearly coincident with that of the containing beds; and as on the Cobequids, its attitude is nearly vertical and it appears to be thickest and richest in the rising grounds. In one very deep ravine the bed of quartzite usually associated with the ore seemed to be wanting, and the vein was represented by innumerable strings of Ankerite, forming a network in the slate. As in the Cobequid vein, masses of Magnetic ore are occasionally mixed with the Specular. To complete

* This vein was first described by the late Mr. Hartley in the Report of the Geological Survey of Canada, 1870.

the resemblance, loose masses of Limonite are found in the vicinity of the vein, giving rise to the expectation that a vein or veins of this mineral may be found to be associated with the specular ore. The ores of this vein in Pictou County are nearly pure peroxide of iron, containing from 64 to 69 per cent. of metal, and can be obtained in great quantity from the outcrop of the vein where it appears on the rising grounds.



Ideal Section, showing the general relations of the Iron Ores of the East River of Pictou.

1. Great bed of Red Hematite.
2. Vein of Specular Iron.
3. Vein of Limonite.

(*a*) Older Slate and Quartzite series, with Trap, &c.
(*b*) Lower Helderberg formation and other Upper Silurian rocks.
(*c*) Lower Carboniferous of the East Branch of East River.

(2) *Limonite veins of the East River of Pictou.*

The valley of the East River of Pictou above Springville is occupied by a narrow tongue of Lower Carboniferous rocks, having at one side the slates containing the ore last mentioned, and on the other a more disturbed country already referred to as containing the great Lower Helderberg bed of Hematite. It is highly probable that the river valley follows the line of an old pre-carboniferous line of fracture, denuded and partially filled with the Lower Carboniferous beds, including large deposits of limestone and gypsum. At the line of junction of the Carboniferous and older rocks on the east side of the river, occurs the great Limonite vein of the district, forming a vein of contact of exceeding richness and value. It follows the sinuosities of the margin of the older rocks, and varies in thickness and quality in different places; being apparently richest opposite the softer slates and where these are in contact with a black manganesian limestone, which here, as in many other parts of Nova Scotia, forms one of the lowest members of the Carboniferous series. The ore is sometimes massive but more frequently in fibrous concretionary balls of large size, associated with quantities of smaller concretionary or "gravel" ore. In some places the ore of iron is associated with concretions or crystalline masses of Pyrolusite and Manganite.

Denuding agencies in the Post-pliocene period have removed portions of the vein and its wells, and have deeply covered the surface in many places with debris. Hence the outcrop of the vein was originally marked by a line of masses of the ore too heavy to be removed by water. From the analogy of the other veins to be mentioned in the sequel, I was led to believe that the source of these masses would be found in the Lower Carboniferous rocks, and so stated the matter in the first edition of Acadian Geology (1855). Subsequently, however, the vein having been exposed in situ, and one wall proving to consist of metamorphic slate, it was described by Dr. Honeyman and by Mr. Hartley of the Geological Survey as a vein in the Silurian rocks. Still more recently exploratory works conducted by Mr. G. M. Dawson, with the aid of Mr. D. Fraser, have clearly proved that the vein follows the junction of the two formations. The ore of this vein is of the finest quality, affording from 62 to 65 per cent. of metallic iron. The more productive portions of this vein, as well as of the specular vein in its vicinity, are in the hands of the parties already referred to, in connection with the Hematite bed.

(3) *Limonite of Shubenacadie, Old Barns and Brookfield.*

At the mouth of the Shubenacadie River, the lowest Carboniferous bed seen is a dark-coloured laminated limestone, in all probability the equivalent of the Manganesian limestone already referred to, as well as of the Manganiferous limestone of Walton, the Plumbiferous limestone of the Stewiacke, and the lower black limestone of Plaister Cove, Cape Breton.* This limestone and the sandstones and marls overlying it, are traversed by large fissure veins, holding a confused aggregation of iron ores and other minerals, as Limonite, Hematite, Gothite, Sulphate of Barium, Calcite, &c., some of which appear sufficiently large and rich for profitable exploration. In the same formations, further to the eastward. at Old Barns, similar veins are found to be largely developed, and at Brookfield, fifty miles east of the Shubenacadie, and apparently near the junction of the Lower Carboniferous with older rocks, large surface masses of Limonite

* See Acadian Geology.

appear to indicate an extensive deposit of similar nature, but which has not, I believe, been yet so far opened up as to establish its practical importance.

(4) *Iron Veins of the Triassic Trap.*

Veins of Magnetite and Specular Iron occur in several localities in the great beds of trap associated with the Triassic red sandstones of the Bay of Fundy, but so far as known these ores are insignificant in quantity.

It will be observed from the above notes, that while the iron vein of the Cobequid hills is at no great distance from the coal-field of Cumberland, with which it has now railway connection, the still larger and more important deposits of Pictou are very near to the extensive collieries of that district, and to railway and water communication, so that every facility appears to exist for their profitable exploration, and it may be anticipated that they will soon be rendered available for the supply of iron of superior quality, more especially to meet the large and increasing demand of the Dominion of Canada.

DESCRIPTIONS OF NEW FOSSILS FROM THE DEVONIAN ROCKS OF WESTERN ONTARIO.

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Having been engaged for some time in studying the fossils of the Corniferous Limestone of Western Ontario, I purpose in the present communication to give brief descriptions of some of the new forms which have come under my notice. I shall, however, simply give the descriptions, without illustrations, as I am preparing a detailed report upon the fossils of some of the Palæozoic formations of Ontario, in which the species in question will be fully illustrated.

I. Zaphrentis fenestrata, n. sp.

Corallum simple, cylindro-conical, curved. Tabulæ well developed, remote, bending downwards as they approach the outer wall. Septa strong, equally developed, not alternately large and small, apparently forty-eight in number. Epitheca thin, with a few shallow undulations of growth, but destitute of vertical striæ or costæ.

This species is closely allied to *Z. gigantea*, Lesueur, but appears to be clearly distinct; though the above description is founded upon but a single specimen, which is all that I have as yet obtained. It differs from *Z. gigantea* in the greater proportionate thickness, a much smaller number of the septa, and in the greater remoteness of the tabulæ. Thus in *Z. gigantea* the septa are from seventy to one hundred and forty in number, and they are alternately small and large; whilst their thickness is not particularly great, and the distance between the tabulæ is not excessive. *Z. fenestrata* is also a smaller form than *Z. gigantea*. From *Z. prolifica*, Billings, the present species is distinguished by its greater size and more cylindrical form, and the much smaller number of the septa, as well as by the fact that the septa are not alternately of different sizes. *Zaphrentis patula* of Edwards and Haime, possesses forty equal septa, but is of a much smaller size, and its shape is much more turbinate. *Z. centralis*, of the same authors, is also very much more diminutive in its dimensions.

The tabulæ of the circumference of the coral in *Z. fenestrata*, where they bend downwards to meet the epitheca, appear to be clearly of the nature of highly developed dissepiments; since they are not placed at exactly the same level in contiguous interseptal loculi. The specific name is in allusion to the peculiar fenestrated appearance exhibited by portions of the coral from which the epitheca has been removed, when the interseptal loculi are seen to be crossed at intervals of from two to three lines by the obliquely descending tabulæ, producing the appearance of a series of oblong fenestrules.

Length of the only specimen observed five inches (real length probably nearly twice as much); diameter of summit one inch and a half. Calice and fosette unknown.

Locality and formation.—Corniferous limestone, Port Colborne.

Genus BLOTHROPHYLLUM (Billings).

"Corallum simple, turbinate or cylindrical. Internal structure consisting of a central area occupied by flat transverse diaphragms, an intermediate area with strong radiating septa, and an outer area in which there is a set of imperfect diaphragms projecting upwards, and bearing on their upper surfaces rudimentary radiating septa. A thin complete epitheca, and a septal fosette." (Billings, Canadian Journ., New Series, Vol. IV., p. 129.)

The central space of the theca is occupied in corals of this genus, as in *Amplexus*, by flat or slightly flexuous tabulæ, upon which the septa encroach slightly or not at all. Outside this central area is a narrow zone in which the tabulæ are bent downwards towards the base of the corallum, and are at the same time occasionally split or bifurcated; whilst the continuity of the spaces between them is interfered with by a series of strong septa. Outside this, again, is an outer zone formed by a series of tabulæ which are directed upwards and outwards in an arching manner, and which carry on their upper surfaces a series of imperfect septa, their lower surfaces being simply costate or ridged. Lastly, the tabulæ of this external zone are walled in by a thin but strong epitheca, with which the outer surface of the coral is invested.

The genus differs from *Zaphrentis* in not having the septa prolonged inwards to, or near to, the centre, and in having the central tabulate area surrounded by an intermediate imperfectly vesicular zone, surrounded in turn by an exterior zone of arched tabulæ and incomplete septa. From *Amplexus* it is distinguished by the possession of the exterior zone last mentioned, and by the septa being more largely developed; whilst it is distinguished from *Clisiophyllum* by the first of the above-mentioned peculiarities, and also by the fact that the tabulæ of the central area are nearly or quite flat, and are not elevated into a conical protuberance.

The genus *Blothrophyllum* was originally defined by Mr. Billings (*op. cit.*), and the single species *B. decorticatum* was described. In addition to this previously recorded and very characteristic species, I have now to describe an allied form, *B. approximatum*, also from the Corniferous limestone of Western Ontario.

II. Blothrophyllum approximatum, *n. sp.*

Corallum of unknown length, cylindrical or cylindro-conical. The outer area consisting of strong arched diaphragms, curving upwards and outwards, distant from one another from half a line to two lines, bearing upon their upper surface imperfect septa which extend from one tabula to another when the tabulæ are remote by the former distance only, but which otherwise do not do so. Septa alternately large and small, distant from one another about a third of a line. Tabulæ of the central area closely approximated, from three to four in the space of two lines, flat or slightly flexuous, the septa only slightly encroaching on them. Epitheca with numerous constrictions of growth and encircling annulations, as well as obscure longitudinal striæ. Dimensions unknown, but certainly attaining a diameter of three inches.

In most of its essential characters this species agrees with *B. decorticatum*, Billings, of which perhaps it may turn out to be only a variety. It is, however, distinguished by the apparently constant peculiarity that the tabulæ of the outer area are very closely set, much more closely than in *B. decorticatum*. Thus, typical specimens of the latter exhibit only from three to five of the curved tabulæ of the outer area in the space of an inch; whereas examples of *B. approximatum* present no less than from ten to fourteen tabulæ in the same space. Whether this character is one of specific value or not, may be questioned, but I think it advisable to refer the specimens which exhibit it, provisionally at any rate, to a new species.

Locality and formation.—Corniferous Limestone of Port Colborne.

Genus HELIOPHYLLUM (Hall).

The genus *Heliophyllum* is very closely allied to *Cyathophyllum*, and the following are the definitions of it, given respectively by Milne Edwards and Haime, and by Mr. Billings:

1. "Corallum simple. Septal apparatus well developed, and producing lateral lamellar prolongations, which extend from the wall towards the centre of the visceral chamber, so as to represent ascending arches and to constitute irregular central *tabulæ*, and which are united towards the circumference by means of vertical dissepiments." (Milne Edwards and Haime.)

2. "Corallum simple or aggregate; radiating septa well developed, obliquely striated on their sides by thin elevated ridges, which extend from the outer wall in an upward curved course towards the centre. These ridges are connected by numerous thin laminæ, which divide the spaces between the septa into small sub-lenticular cells. The transverse diaphragms are thin,

flexuous, and confined to the central portion of the coral." (Billings.)

The internal structure which distinguishes corals of the genus *Heliophyllum* is thus of a somewhat complicated nature. The septa are well developed and extend nearly or quite to the centre of the theca, where they are often somewhat twisted; but there is no columella. A central tabulate area exists, but is of comparatively circumscribed dimensions. Externally to this tabulate area, the interseptal loculi are divided into cells or small compartments by the intersection of two sets of dissepiments having different directions. The dissepiments of the first and most conspicuous set are directed from the internal surface of the wall obliquely inwards and upwards towards the centre, in a succession of arches, the convexities of which are turned upwards. These dissepiments doubtless correspond with that circumferential portion of the tabulæ, which is bent downwards towards the base of the coral in species of *Zaphrentis*, *Clisiophyllum*, *Diphyphyllum*, &c. When these dissepiments are more or less imperfect or have suffered destruction, they leave upon the flat surfaces of the septa a corresponding number of arched striæ or ridges. Similarly, in the calice of the coral these dissepiments appear on the free edges of the septa as so many short spines. The dissepiments of the second series are more delicate, more discontinuous, and much more variable in direction than those of the preceding series. Sometimes they are nearly vertical, or, in other words, are pretty nearly concentric with the theca. Sometimes they are not far from the horizontal, and intersect the dissepiments of the former series at a very acute angle. Most commonly they are directed inwards and downwards from the theca towards the centre, so as to cut the dissepiments of the preceding series nearly at right angles. Decorticated examples of *Heliophyllum* exhibit a most characteristic appearance, due to the intersection of the septa and filled-up interseptal loculi with the dissepiments of the first mentioned series. In this way is produced a succession of vertical ridges and intervening sulci crossed by numerous curved or sharply zig-zagged encircling ridges.

The species of *Heliophyllum* which have been described by Mr. Billings as occurring in the Devonian rocks of Canada, are *H. Eriense*, *H. Cayugaense*, *H. Canadense*, *H. exiguum*, *H. colligatum*, *H. Halli*, and *H. tenuiseptatum*, the first five from the Corniferous formation, and the last two from the Hamilton shales. All these, except *H. tenuiseptatum*, have come under my notice as occurring in the Corniferous Limestone of Western Ontario, and I have also a single new form to record.

III. Heliophyllum Colbornense, n. sp.

Corallum simple, cylindrical, not expanding towards the cup. Septa sixty at a diameter of one inch, carrying on their flat surfaces arched striæ at distances of from one-third to half a line. Epitheca with numerous rounded or sharp-edged annulations and constrictions of growth. A flat space at the bottom of the cup, to the centre of which the septa extend. Cup deep; fossette unknown.

This species is nearly related to *H. Cayugaense* and *H. Canadense*, Billings; but it is, I think, decidedly distinct. It is distinguished from *H. Canadense* by its cylindrical and not broadly-expanding shape, the cup being equal to or even less than the diameter of the coral at a point apparently a little above the base; by the flattening of the bottom of the calice; by the greater closeness of the arched septal striæ; and by the smaller number of septa. From *H. Cayugaense* the present species is separated by its much smaller thickness, its cylindrical, not expanding form, the smaller number of the septa, and the closeness of the septal striæ.

The length of *H. Colbornense* must have been over three or four inches; but none of my specimens are perfect. The dimensions of a broken individual are: length two inches and a-half; diameter of broken base one inch; diameter of cup ten lines; depth of cup four lines. In another also broken specimen, the length is two inches and a quarter; the diameter at the broken base thirteen lines; the diameter of the cup one inch; and the depth of the cup five lines. Other examples referable to this species exhibit a diameter of from an inch and a quarter to an inch and a half.

Locality and Formation.—Corniferous limestone of Port Colborne.

IV. Petraia (?) Logani, n. sp.

Corallum small, turbinate, more or less curved, almost trigonal in transverse section, owing to its being flattened on the side of the convex curvature, and also on the lateral surfaces. Septa twenty-six or twenty-eight at a point a little above the base, but sixty or more at the margin of the calice, the increase of number being due to the bifurcation of each primary septum at a distance of about a line and a-half above the base, and also to the intercalation of new septa along both sides of a line which runs along the dorsal or convex side of the coral from top to bottom. This line is marked on the exterior by two primary septa, which form a prominent ridge externally and pass inwards to the centre of the coral. At the margin of the cup the septa are somewhat unequally developed, being alternately larger and smaller, the larger primary septa being prolonged inwards to the centre of the theca, where they become somewhat bent and twisted together. No columella appears to be present, nor are there any *tabulæ*. The flat sides of the septa are furrowed with a succession of deep grooves, about four or five in the space of one line, which are directed in an obliquely ascending and arching manner from the wall towards the centre, the interspaces between them being tumid and rounded, and thus imparting a crenulated appearance to the outer edges of the septa when exposed to view. These arching grooves are not connected with lamellar dissepiments having a similar direction; but the septa for some little distance below the cup are united by delicate transverse dissepiments. The epitheca is marked with a few annulations of growth, which are mostly very obscure, and with well marked costæ or striæ corresponding with the septa.

In none of the specimens in my possession does the epitheca extend more than half an inch (often less) above the base of the corallum. Beyond this point to the margin of the calice, the edges of the septa are seen with their characteristic crenulated appearance, and united here and there by minute dissepiments. As already noted, the flattened convex side of the coral always exhibits two pre-eminently large septa, produced by the bifurcation of one, which run from the top to the bottom of the coral in a straight line. The remaining septa are directed obliquely from both sides towards this central pair; so that new septa are intercalated along this line in proceeding from the base to the calice. It is possible that these two septa may mark the position of a fosette in the cup; but none of my specimens exhibit the interior of the calice, and I am, therefore, unable to speak positively on this point. For the same reason I can say nothing as to the condition of the free edges of the septa internally.

The total length of the corallum is from three-quarters of an inch to one inch, the diameter of the calice varying from half an inch to nearly three-quarters. The calice is oblique, so that the greatest length of the coral is along its convex curvature.

Petraia Logani is closely allied to *Petraia* (*Turbinolopsis*) *pluriradialis*, Phillips, with which I was at first sight disposed to identify it. It is, however, readily distinguished by the flattening of the convex curvature and lateral aspects of the coral, and by the smaller number of radiating septa. As regards other more minute characters, the published descriptions of *P. pluriradialis* are not sufficient to enable any closer comparison to be instituted with advantage between the two species.

There exists also a singular, and in some respects inexplicable, resemblance between the form here described under the name of *P. Logani*, and that described by Mr. Billings under the name of *Heliophyllum exiguum* (Can. Journ. New Series, Vol. V. p. 261); at the same time that differences of such gravity exist that the two forms cannot be united under the same specific title, or even placed in the same genus. Without pretending at present to explain the discrepancies of observation here alluded to, it may be as well to present in a summary form the points of agreement and difference which appear to exist between the two species.

1. Both corals are of the same general form and size, and occur not only in the same formation, but also at the same locality.

2. Both corals are alleged to possess externally a couple of straight septal ridges, extending from the top to the bottom of the coral, and having the other septa directed obliquely towards this line on both sides. I have, however, never been able to detect this structure in the comparatively few specimens which have come under my notice, which I should feel disposed to refer to *H. exiguum*.

3. The number of septa in the cup appears to be about the same in both, though said to be sometimes as many as eighty in *H. exiguum*, whilst they never appear to exceed sixty-five in *P. Logani*.

Whilst the above are the chief points of agreement, there are the following points of difference to be noted:

1. *H. exiguum*, though this is not specially alluded to, must possess more or less well developed *tabulæ*; but no traces of such structures can be detected in *P. Logani*, in broken specimens or in longitudinal sections.

2. The septa in *H. exiguum* exhibit on their flat sides "about six obscure arched *striæ* to one line." Those of *P. Logani* exhibit a succession of arched *grooves* of considerable depth, separated by somewhat tumid interspaces; and these grooves are only about fo·· ·r five in the space of one line. Nor can it be supposed that this discrepancy is due to any confusion on my part between *casts* of *P. Logani* and the actual coral itself, such a mistake being impossible in dealing with the well-preserved specimens of the Corniferous formation.

3. The septa in *P. Logani* bifurcate regularly in proceeding from the base to the cup, thus being always arranged in pairs in the upper part of the coral; whilst no such arrangement is stated as regards *H. exiguum*.

4. When looked at as seen in transverse sections of the cup, the septa of *H. exiguum* are seen to possess plain sides, as is the case in *Zaphrentis;* whilst those of *P. Logani* are denticulated with tooth-like dissepiments or spines, which rarely extend to the contiguous septum. It need hardly be said that the structures here alluded to are not to be confounded with the spines which occur on the *free edges* of the septa of *H. exiguum*, as in the genus *Heliophyllum* in general.

5. The epitheca of *H. exiguum* is thick, deeply annulated, hardly showing the lines of the septa, and co-extensive with the outer surface of the coral. In *P. Logani*, on the other hand, the epitheca is very slightly marked with ridges of growth, usually exhibits distinct costæ, and never appears to extend to the margin of the calice; though it is certainly difficult to say positively whether this last appearance is natural or is due to a partial decortication of the coral.

Upon the whole, I think that the fossil here described as *Petraia Logani* is distinct from previously known forms. Its reference to *Petraia* is provisional, but it apparently cannot be referred under any circumstances to the genus *Heliophyllum*. I have named it in honour of the eminent geologist, Sir William Logan, F.R.S.

Locality and formation.—Not uncommon in the Corniferous Limestone of Rama's Farm, Port Colborne.

V. Alecto (?) Canadensis, n. sp.

Polyzoary adnate, attached parasitically to the exterior of corals, branching in an irregularly dichotomous manner. Cells in reality uniserial, but so disposed by the turning of each cell-mouth to alternate sides as to look as if bi-serial. The terminal portion of each cell bent outwards; the aperture circular. The cells tubular, elongated, slightly or not at all expanded and not at all elevated towards their apertures. Five cells in the space of two lines; width of cell about one-fiftieth of an inch near the mouth.

I have considerable doubts as to the affinities of this extraordinary little fossil; but I think it is certainly one of the Cyclostomatous Polyzoa, and I see at present no better course than to refer it to *Alecto*, Lamoroux. When not examined closely, the fossil presents a striking resemblance to a Sertularian Zoophyte, exhibiting exactly the appearance of a number of tubular calycles or cells springing alternately from the two sides of a common canal or stem. When minutely looked into, however, it is seen that this is deceptive, and that the fossil consists really of an alternate or sub-alternate series of long, tubular, slightly flexuous cellules, each cell being nearly cylindrical, and having the terminal portion geniculated or bent outwards, in such a manner that the mouths of successive cells point in opposite directions.

The difficulty in determining the systematic place of this fossil is much increased by the fact that it occurs solely in the form of casts, ramifying in the walls of moulds from which corals have been removed. It is, therefore, impossible to determine what was the texture of the cœnœcium, whether calcareous or corneous; whilst the lines of division between the cells, where they come in contact with one another, are only very faintly and obscurely indicated. The form of the aperture of the cell appears to have been circular, and its position terminal; but some uncertainty attaches to both of these statements.

Locality and Formation.—Common, growing parasitically upon the corallites of *Diphyphyllum arundinaceum*, or upon the epitheca of *Fistulipora Canadensis*, in the former position generally accompanied by a species of *Spirorbis*. Corniferous Limestone, Port Colborne, and Lot 6, Con. 3, Wainfleet.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

At the recent meeting of the American Association held at Portland, a large number of interesting papers were read, one of which, by Principal Dawson, is given in full in the present number of this journal.

We have, as yet, been unable to obtain full reports of the proceedings; but give a few abstracts of some of the most interesting papers and discussions, *from the reports of the New York Tribune.*

ADDRESS OF THE PRESIDENT.

The address of J. Lawrence Smith, the retiring President, was read by Prof. Putnam, the President being absent in Vienna. The following is given by the *Tribune* as the most significant portion:

It is not my object to criticise the speculations of any one or more of the modern scientists who have carried their investigations into the world of the imagination; in fact, it could not be done in a discourse so limited as this, and one only intended as a prologue to the present meeting. But in order to illustrate this subject of method more fully I will refer to Darwin, whose name has become synonymous with progressive development and natural selection, which we had thought had died out with Lamarck 50 years ago. In Darwin we have one of those philosophers whose great knowledge of animal and vegetable life is only transcended by his imagination. In fact, he is to be regarded more as a metaphysician with a highly wrought imagination than as a scientist, although a man having a most wonderful knowledge of the facts of natural history. In England and America we find scientific men of the profoundest intellects differing completely in regard to his logic, analogies, and deductions; and in Germany and France the same thing—in the former of these countries some speculators saying "that his theory is our starting-point," and in France many of her best scientific men not ranking the labors of Darwin with those of pure science. Darwin takes up the law of life and runs it into progressive development. In doing this he seems to me to increase the embarrassment which surrounds us on looking into the mysteries of creation. He is not satisfied to leave the laws of life where he finds them, or to pursue their study by logical and inductive reasoning. His method of reasoning will not allow him to remain at rest; he must be moving onward in his unification of the universe. He started with the lower order of animals, and brought them through their various stages of progressive development until he supposed he had touched the confines of man; he then seems to have recoiled, and hesitated to pass the boundary which separated man from the lower order of animals; but he saw that all his previous logic was bad if he stopped there, so man was made from the ape (with which no one can find fault, if the descent be legitimate). This stubborn logic pushes him still further, and he must find some connecting link between that most remarkable property of the human face called expression; so his ingenuity has given us a very curious and readable treatise on that subject. Yet still another step must be taken in this linking together man and the lower order of animals: it is in connection with language; and before long it is not unreasonable to expect another production from that most wonderful and ingenious intellect on the connection between the language of man and the brute creation.

Let us see for a moment what this reasoning from analogy would lead us to. The chemist has as much right to revel in the imaginary formation of sodium from potassium, or iodine and bromine from chlorine, by a process of development, and call it science, as for the naturalist to revel in many of his wild speculations, or for the physicist who studies the stellar space to imagine it permeated by mind as well as light—mind such as has formed the poet, the statesman, or the philosopher. Yet any chemist who would quit his method of investigation, of marking every foot of his advance by some indelible imprint, and go back to the speculations of Albertus Magnus, Roger Bacon, and other alchemists of former ages, would soon be dropped from the list of chemists and ranked with dreamers and speculators.

What I have said is, in my humble opinion, warranted by the departure Darwin and others have made from true science in their purely speculative studies; and neither he nor any other searcher after truth expects to hazard great and startling opinions without at the same time courting and desiring criticism; yet dissension from his views in no way proves him wrong—it only shows how his ideas impress the minds of other men. And just here let me contrast the daring of Darwin with the position assumed by one of the great French naturalists of the present day, Prof. Quatrefages, in a recent discourse of his on the physical character of the human race. In referring to the question of the first origin of man, he says distinctly, that in his opinion it is one that belongs not to science; these questions are treated by theologians and philosophers: "Neither here nor at the Museum am I, nor do I wish to be, either a theologian or a philosopher. I am simply a man of science; and it is in the name of comparative physiology, of botanical and zoölogical geography, of geology and palæontology, in the name of the laws which govern man as well as animals and plants, that I have always spoken." And studying man as a scientist, he goes on to say: "It is established that man has two grand faculties of which we find not even a trace among animals. He alone has the moral sentiment of good and evil; he alone believes in a future existence succeeding this natural life; he alone believes in beings superior to himself, that he has never seen, and that are capable of influencing his life for good or evil; in other words, man alone is endowed with morality and religion." Our own distinguished naturalist and associate, Prof. Agassiz, reverts to this theory of evolution in the same positive manner, and with such earnestness and warmth as to call forth severe editorial criticisms, and by his speaking of it as a "mere mine of assertions," and "the danger of stretching inferences from a few observations to a wide field;" and he is called upon to collect "real observations to disprove the evolution hypothesis." I would here remark, in defence of my distinguished friend, that scientific investigation will assume a curious phase when its votaries are required to occupy time in looking up facts, and seriously attempting to disprove any and every hypothesis based upon proof, some of it not even rising to the dignity of circumstantial evidence.

I now come to the last point to which I wish to call the attention of the members of the Association in the pursuit of their investigations, and the speculations that these give rise to in their minds. Reference has already been made to the tendency of quitting the physical to revel in the metaphysical, which, however, is not peculiar to this age, for it belonged as well to the times of Plato and Aristotle as it does to ours. More special reference will be made here to the proclivity of the present epoch among philosophers and theologians to be parading science and religion side by side, talking of reconciling science and religion, as if they had ever been unreconciled. Scientists and theologians may have quarreled, but never science and religion. At dinners they are toasted in the same breath, and calls made on clergymen to respond, who, for fear of giving offense, or lacking the fire and firmness of St. Paul, utter a vast amount of platitudes about the beauty of science and the truth of religion, trembling in their shoes all the time, fearing that science falsely so-called may take away their professional calling, instead of uttering in a voice of thunder, like the Boanerges of the gospel, that "the world by wisdom knew not God." And it never will. Our religion is made so plain by the light of faith that the wayfaring man, though a fool, cannot err therein.

No, gentlemen; I firmly believe that there is less connection between science and religion than there is between jurisprudence and astronomy, and the sooner this is understood the better it will be for both. Religion is based upon revelations as given to us in a book, the contents of which are never changed, and of which there have been no revised or corrected editions since it was first given, except so far as man has interpolated; a book more or less perfectly understood by mankind, but clear and unequivocal in all essential points concerning the relation of man to his Creator; a book that affords practical directions, but no theory; a book of facts and not of arguments; a book that has been damaged more by theologians than by all the Pantheists and Atheists that have ever lived and turned their invectives against it—and no one source of mischief on the part of theologians is greater than that of admitting the profound mystery of many parts of it, and almost in the next breath attempting some sort of explanation of these mysteries. The book is just what Richard Whatley says it is, viz.: "Not the philosophy of the human mind, nor yet the philosophy of the divine nature in itself, but, (that which is properly religion) the relation and connection of the two beings—what God is to us, what He has done and will do for us, and what we are to be in regard to Him." * * * Let us stick to science, pure, unadulterated science, and leave to religion things which pertain to it; for science and religion are like two mighty rivers flowing toward the same ocean, and before reaching it they will meet and mingle their pure streams, and flow together into that vast ocean of truth which encircles the throne of the great Author of all truth, whether pertaining to science or to religion. And I will here in defence of science assert that there is a greater proportion of its votaries who now revere and honor religion in its broadest sense, as understood by the Christain world, than that of any other of the learned secular pursuits.

THE EVOLUTION THEORY.

This subject elicited a somewhat lengthy discussion, in which Principal Dawson, Prof. Morse, Prof. Swallow and Prof. Gill took part. The following is the substance of Principal Dawson's and Prof. Morse's remarks:

Dr. Dawson began by stating with some fullness of detail the demands upon our credence made by the advocates of the evolution theory. Among other requirements of the theory, he said it must provide an explanation of the origin of life. To accomplish this the experiments of Bastian were brought forward. Referring to these, he stated that no less an authority than Prof. Huxley, though an evolutionist, had denied their conclusive character and disputed the alleged results. We are expected to admit, in every department to which scientific inquiry relates, that in all things there has been a successive progress from the lower to the higher. Why should we make this admission? What proof is there of it? The recent discoveries of embryology, showing the likeness of early forms of the embryo to other animals of the same families, furnished to the advocates of evolution no real argument in its favor. They proved nothing. Admit, if you will, the close resemblance of similar bones and general physical structure in the ape and man, it is not the slightest evidence of identity. While it may be true that there is bone for bone in monkey and in man, still it remains that the bones of one are different from those of the other. The making of monkey and of man is explicable quite as readily, to say the least, on the theory of plan as on that of evolution. The history of the growth of an animal has been cited as the evidence of a development from a lower to a higher form. But what are the facts in the case? The egg grows into the animal, and that organism produces an egg again. This is *revolution*, not evolution.

We are told to accept as a postulate that mind too is the result of development; that the moral as well as the material being is simply a consequence of the evolving process. I do not grudge the naturalists who have adopted such theories the intellectual exercise which is involved, but I regret that much of their labor is wasted, and the results will be burnt when the fires of truth are applied to the chaff they are accumulating. This is not a question of physics that they are arguing, it is one of metaphysics, and it would be well for our children, as well as growing scientists, if they were taught more of mental and moral philosophy as a basis for such inquiry. But I thank the students who are thus engaged for some good results of their exertions. They have thereby succeeded in reducing the superfluous numbers of species, and have obtained far better views in respect to classification.

Good results will also flow from the profound embryological researches of the day. But I am sorry for the investigators, for their reputations are at stake, and they have chosen a mistaken path.

We are, however, approaching in our studies a correct theory. After its appearance in geological history, every species has a plastic tendency to spread to its utmost limits of form. Then ensues a period of decadence until it may become extinct. This has been set forth in some of my printed memoirs on the plants of the carboniferous series. I believe that a similar process is true of the human race. He referred to the skull of Mentone and its finely developed character—a grandly developed man cerebrally and bodily. The burial of his dead testified to his religious belief. The people of the Cromagno skull age were of a similarly elevated character. The only point of difference from men to-day was in the flattening of one of the leg bones This was perhaps a result of the habits of the tribe, running through forests in pursuit of game. It begins to be admitted that the man of Western Europe came in with the modern mammalia at the close of the glacial period. This was a period of decadence, and when the pliocene fauna were dying out and new forms were taking their places. The most ancient form of man is beyond the average standard of modern humanity. If the man of Cromagno or Mentone had been sent to Harvard, he would have been graduated with the full honors of an average American student.

Professor Morse rose and stated that the forty minutes allowed for this discussion would scarcely leave time to touch its salient points. It was a question whose bearings might consume a week in their consideration. But a few things might be said. Dr. Dawson and Professor Swallow had both misquoted Huxley, who had said, in respect to the ancient skull referred to, that it might have held the brains of a thoughtless savage, or it might have contained those of a philosopher. Dr. Dawson had referred to only the differences in those remains from those of to day in respect to the flattened tibia. There were, however, several other characters of a similar nature which Dr. Dawson had not referred to, some of which had been discovered by Prof. Wyman, and had not yet been published. In the existing races of man the *foramen magnum* (the large opening at the base of the skull through which the brain communicates with the spinal cord) exhibited very little change of position in its relation to the rest of the skull, while with the higher primates (apes) this opening is very near the posterior portion of the skull. This was illustrated by a rapid drawing on the blackboard. In eleven ancient skulls from the shell heaps of Tennessee, the *foramen magnum* in every case was nearly an inch further back than in those of present existing races. The powerful muscles on the sides of the head that move the jaws leave a distinct line at their upper points of attachment. These lines are called temporal ridges. In all present existing races a space occurs on the top of the skull, between these lines, of from three and a half to four inches. In the apes these muscles meet in the median line which rises into a bony crest so characteristic of the gorilla. There was a remarkable skull discovered by Prof. Wyman in the lowest beds of the ancient shell heaps of Florida. This has the temporal ridges approaching each other within a half inch at the top of the skull. If the high development of the skull referred to by Mr. Dawson was such as he states, it only carries man further back. Similarly in the light thrown upon the history of man by the wonderful discoveries in archæology, where we meet with traces of an ancient civilization, with complicated language and manners, we can surely believe in savage hordes pre-existing from which this ancient civilization has been evolved.

As to the early traces of man we must fully appreciate the rare possibility of their occurrence. Wherever you dredge in the waters of the present day the traces of man are among the rarest discoveries. The Lake of Haarlem, upon whose waters naval battles have been fought, and on whose shores a dense population has existed, was drained, and on its bottom not the slightest traces of man's existence were found. Prof. Morse dredged repeatedly for years off the shores of Maine, and no trace of man was ever brought up, except a single spike. When we consider how abundant the material for such remains must be now compared with those furnished by the simple methods of life and the sparse population of earlier days, the indications of man's existence in geological eras must be of the rarest occurrence. In fact, in such rocks as the drift, only the rude stone implements could be preserved.

Alluding to the brief moments left for the debate, Prof. Morse said there was but time to say that the evolution theory, as compared with that of special creation, presented similar features to the undulatory theory of light as compared with the emission theory. Newton's theory required a new modification with every discovery in optics, until, as a writer said at that time, the emission theory is a mob of hypotheses. The undulatory theory of Young not only explained all that was dificult to Newton, but gave physicists the power of prevision. So with evolution; it not only accounts for existing phenomena from the modification of a flower or the spot on a butterfly's wing to the genesis of the solar system, but it has endowed naturalists with the gift of prophecy and enabled them to predict the intermediate forms afterwards discovered in the records of the rocks.

CALVERT'S SUPPOSED RELICS OF MAN IN THE MIOCENE OF THE DARDANELLES.

By GEORGE WASHBURN, Hobart College.

Sir John Lubbock announced not long ago that Mr. Calvert had discovered evidence at the Dardanelles of the existence of man in the Miocene period. He reported that 800 feet below the surface flint instruments had been found; also, bones split lengthwise, but especially a fossil bone upon which had been engraved a picture of a horned animal. The author, in company with Mr. Forbes, Instructor in Mathematics in Hobart College, visited the spot last April, and found Mr. Calvert engaged in mining and ready to aid them. The deposits were found midway between the Dardanelles and the plains of Troy. The hills rise abruptly about 800 feet above the Straits, and are cut by deep ravines which exhibit the formation.

The lowest formation exposed at this point is an argillaceous limestone nearly white, containing no fossils, of irregular thickness, and smooth, like pressed clay, on its upper surface. Above this are irregular beds of earth and clay of different colors; next is a deposit of white sea-sand 500 feet thick, which contains, at irregular intervals, pebble beds from one to four feet thick; next is a bed of shell limestone at least 100 feet thick. These shells are of the brackish water variety. Tchiuatheff, in his "Asia Minor," calls this Miocene. The fossils and flints were closely examined, and the investigators arrived at the conclusion that they were shaped by the action of water. Teeth of the mastodon and parts of tusks were found. The bones found were in so small fragments that it was not possible to determine them. Similar fragments of flint, exhibiting no other action than that of water, were found in abundance in the pebble formation near Dardanelles, and it was only a question of selecting from piles of stones those that happened to take a certain shape.

Mr. Calvert has in his collection several bones split lengthwise, with the marrow gone. This cannot be denied: But it is to be doubted if such bones proved the existence of human beings. They found in the hole of a jackal, on the plain of Troy, sheep bones which had also been split lengthwise, and they inferred that if the bones were split they were the work of beasts. But it is very doubtful if the bones found were broken in this way; for they found that when one of the whole bones was dropped it broke lengthwise, and as all the marrow was gone, it resembled the split bones.

The bone with the supposed engraving is a fragment about eight inches in diameter, shaped like a flattened sphere, one surface smooth, the other rough. It has been called the bone of a Mastodon or of a Dinotherium, but is so small that it cannot be determined. Mr. Calvert has had it about 20 years, but only lately, since he read Sir John Lubbock's book on bones in France, has he distinguished the engraving upon it. The smooth surface has some 50 marks, more than half which are grouped in the centre. Taken individually, they are peculiar and puzzling, but taken together, they can hardly represent a sketch of an animal, or show an evidence of design. They were unable to account in a satisfactory manner for the marks, but suggested they might have been produced by worms when the bone was soft. They found the smooth upper surface of the underlying stratum of limestone was covered with exactly similar marks, many groups of which made more striking pictures than those found on the bone. One specimen is so marked that a vivid imagination can distinguish the picture of a wild boar with a spear in his side, with the Greek letter II most clearly cut by the side of it. No one would dream of attributing all the marks upon the rocks to design, and he thought it equally unreasonable to so attribute the similar marks upon the bone to human agency.

The author reports, therefore, in view of the facts mentioned above as to the flints, the split bones, and the marks upon the fossil bone, that they believe that Mr. Calvert and Sir John Lubbock (who had never seen the specimens) are mistaken in the conclusions to which they have come, and that they have not been able to find any evidence whatever at the Dardanelles in reference to the antiquity of man.

ON THE RELATIONS OF THE NIAGARA AND LOWER HELDERBERG GROUPS OF ROCKS AND THEIR GEOGRAPHICAL DISTRIBUTION IN THE UNITED STATES AND CANADA.

By Prof. James Hall.

The speaker, before proceeding to the discussion of the subject, cited a paper read by Mr. A. H. Worthen at the Troy meeting of the Association, entitled, "Remarks on the relative age of the Niagara and the so-called Lower Helderberg Groups," in which that writer proposed to drop the name of the latter group on the ground of its equivalence with the Niagara. The results of careful field investigation, and the study of the fossils over wide areas for 30 years, it undertakes to set aside, without offering the evidence of any new investigations, or of arguments which could be admitted as proof. Coming from a gentleman holding the position of State Geologist of Illinois, the matter was worthy of the careful attention of the Association. The speaker stated that this view was not original with Mr. Worthen, but was the prevalent opinion among geologists previous to the last 30 years, citing Prof. H. D. Rogers and other authors, giving some details in regard to the causes of the misunderstanding of the geological structure of the country. Here, upon a map of the United States, the colored belts which indicated the formations referred to, he first traced the Niagara group from its typical locality at Niagara Falls, where the formation of shale and limestone has a thickness of over 200 feet, to the eastern portion of the State, where from gradual thinning it sometimes has a thickness of not more than 8 feet, and is known as the coralline limestone. The rock was nevertheless marked by the characteristic fossils, and its place in the series clearly preserved. Returning to the Niagara river, the speaker traced upon the map the course of the Niagara group through Ontario to Cabot's Head, thence by the islands of Lake Huron and the peninsula between Green Bay and Lake Michigan, and thence along the west shore of that lake to its southern extremity; from this point the formation extends in a westerly and north-westerly direction through Illinois and Wisconsin, and thence into Iowa.

Returning thence to the western end of Lake Erie, the Niagara formation was found composing some islands, and extending south-westerly into the State of Ohio and into Kentucky. Over all this area the formation is well defined, and no one had questioned its character. The same formation was also known in Southern Illinois and Missouri, and likewise in Tennessee, where its integrity has been called in question. In Illinois and Tennessee it was claimed that the fossils of the Niagara formation are mingled with those of the Lower Helderberg group. He then proceeded to speak of the rocks of this group as known in its best developments in the Helderberg Mountains and on the banks of the Schoharie and Cobles Kil. The members of the formation are the Tentacalite limestone, the Lower Pentamerus limestone, the shaly limestone, and the Upper Pentamerus limestone, these together constituting a group quite unlike the Niagara group, while of the hundreds of fossils which they contain none are identical with those of the Niagara. These beds in the Schoharie Valley lie above the coralline limestone, which has been shown to be a continuation of the Niagara formation and to be separated from that by a distinct formation known as the water-lime.

On tracing this Lower Helderberg formation on the map, it was shown to thin out in its westerly extension until it was recognized only as a simple band of limestone without fossils. Here, returning to the Helderberg Mountains, the formation could be traced to the Hudson River Valley, and along this valley to the southern part of the State, thence through New-Jersey, Pennsylvania, Maryland, Virginia, and thence into Tennessee. Throughout the greater part of this extent the formation is underlaid by the water-lime formation, and the purity and identity of the formation has not been questioned. Looking to the north-east, the formation is known as lying unconformably over lower rocks, and it had been traced as far as Gaspe on the St. Lawrence, and was known in Maine and New Brunswick. The formation could be traced from the 43rd parallel to the 35th parallel, and this extent, taken in connection with the exposures from the erosion of anticlinals where the rocks are folded, will give us more than 2,000 miles of outcrop where the rocks were characterized by fossils, often in great numbers, and where the mingling with other fossils was unknown. After having thus hastily sketched the ground occupied by these groups of strata, the speaker went on to consider their relations to each other, showing sections at different points from the Schoharie Valley to Central New York, and by a diagram tracing the lines of outcrop and comparative thickness of the several formations over this area. Then calling attention to the asserted mingling of the fossils of the two groups in Illinois and Tennessee, as claimed by Mr. Worthen, he asserted that from his own experience on the Mississippi River no such mingling of fossils is known, except in the debris of the formation; that the Niagara formation, greatly thinned out, lies below the beds of the lower Helderberg beds, and the fossils are quite distinct. In Tennessee, Safford has shown that the formations are quite distinct, each characterized by its own fossils. It was true that Safford had said that along the line of junction the fossils were sometimes mingled; but, in the speaker's mind, the fact did not prove them cotemporaneous; for the Lower Helderberg beds with their living shells and other fossils might have been deposited directly upon the dead fauna of the preceding groups, and thus an apparent mingling produced. That these formations were nowhere cotemporaneous was proved by the great thickness of intervening beds in New York and Canada, where sometimes these intervening rocks were over 1,000 feet thick. He concluded by saying that in reversing the facts and considering the known range and extent of the Niagara and Lower Helderberg groups, their close approximation of actual contact over large areas, and their wide separation elsewhere, there are no two groups of similar composition in the entire palæozoic series so clearly distinct and so unmistakably traceable in their physical and lithological character, as well as in their contained fossils.

BREAKS IN THE AMERICAN PALÆOZOIC SERIES.

By Prof. T. Sterry Hunt.

The author began by considerations on the value and significance of breaks in the succession of strata and of organic remains; he then referred to the classification of the palæozoic rocks of the New York series, and showed that Hall in 1842, and again in 1847, pointed out the existence therein of a fauna older than what was then called Silurian by Murchison, or was known in Great Britain, maintaining that our comparison with British rocks must commence with the Trenton limestone, the equivalent of the Llandeilo or Upper Cambrian of Sedgwick (Lower Silurian of Murchison). *The rocks below this horizon* in America were the equivalent of the Lower Cambrian of Sedgwick, which, when they were found to be fossiliferous were *wrongly claimed by Murchison as part of the Silurian.* He sketched the history of the introduction of the nomenclature of Murchison into our American geology, and then proceeded to show the existence of a break both stratigraphical and palæontological at the base of the Trenton. The contact between the calciferous sandrock and the unconformably overlying Trenton is seen in Herkimer County, N.Y., according to Hall. The so-called fossiliferous Quebec group of Logan, the primal and auroral of Rogers, which extends along the great Appalachian valley from the Lower St. Lawrênce to Georgia, corresponds to the Lower Cambrian, and the Potsdam Calciferous and Chazy formations are its equivalents in the valley of the Ottawa and Lake Champlain much reduced in thickness. These are overlaid by the rocks of the Trenton and Hudson River groups (Upper Cambrian) which in various localities to the north overlap the older fossiliferous rocks, and repose on the crystalline rocks, indicating a considerable continental movement corresponding to the break in palæontological succession. *The relation between* these is explained by Logan as resulting from a movement posterior to the deposition of the Hudson River group, which produced a great uplift of several thousand feet, extending for more than 1,000 miles. While showing that there have been movements in parts of the region since that period, the author rejects the explanation, and shows that the relation between the two is due to the fact that the Trenton and the Hudson River rocks overlie unconformably the disturbed Quebec group or Lower Cambrian. These two great series correspond to the rocks of the first and second faunas of Barrande. The second great break is at the summit of the Hudson River group, and is marked by the Oneida conglomerate in New York, and a similar one in Ohio, described by Newberry, The rocks above, to the base of the Corniferous limestone in the New York series, are the Upper Silurian of Murchison, or Silurian proper, and hold what is called by Barrande the third fauna. As long since shown by Hall they are, however, to be divided on palæontological grounds into two groups, the lower including the Medina, Clinton, and Niagara formations, and the upper what was named the Lower Helderberg group. These are separated in New-York and Ontario by the great non-fossilliferous Onondaga group, holding salt and gypsum, and deposited from a great mediterranean salt lake. The close of the Onondaga was marked by another period of disturbance which, like that preceding the deposition of the Trenton, changed the levels and caused the ocean waters to spread alike over the Onondaga formation and the adjacent rocks, which had formed the ancient sea barrier. Then were deposited the Lower Helderberg limestones, followed by the Oriskany sandstone, together constituting a fourth natural division of our palæozoic rocks. These strata were deposited unconformably over the Trenton and Hudson River rocks, in the St. Lawrence valley, and in various localities among the Appalachian hills in New England and the British Provinces. Over this whole region there are no known representatives of the second, and, except to the far eastward, none of the third, or Medina-Niagara fauna. The fourth or highest Silurian fauna corresponds to the Ludlow rocks of Britain, or Upper Silurian of the Canada Survey; while for the third fauna they have applied the name of Middle Silurian. The necessity for such a division in accordance with the views of Hall is admitted, but the name is to be rejected, since the rocks immediately below it are properly not Lower Silurian but Upper Cambrian. Evidence of a fourth break between the Oriskany and the Corniferous were mentioned, in the erosion of the former in New-York and Ontario, although to the eastward in Gaspé, they form a continuous series. The author closed by a tribute to the memory of the venerable Sedgwick, the Nestor of British geologists, who died last Winter, and to the labours of Prof. Hall, who, in his vast work on our palæozoic geology, has reared to himself an imperishable monument.

THE METAMORPHISM OF ROCKS.

By Prof. T. Sterry Hunt.

The various changes which rocks undergo under the influence of water, air, and various gases, and their changes in molecular structure, were briefly noticed, and the use of the name of metamorphic rocks, as now generally applied to crystalline strata, considered. While some geologists had supposed that many of these, such as gneisses, green-stones, serpentines, talcose, and chloritic rocks were igenous products, more or less modified by subsequent chemical precesses, others maintained that they were formed by aqueous sedimentation, and subsequently crystallized. This was taught by Hutton, and when, early in this century, the crystalline rocks of the Alps were shown to rest upon uncrystalline fossiliferous strata, it was suggested that the overlying crystallines were newer rocks, which had undergone a metamorphism from which those directly beneath had been exempted. This notion spread until the great crystalline centre of the Alps was considered to be in part of secondary and even of tertiary age. The history of the extension of this notion to Germany, to the British Islands, and to New England, was then sketched, and it was shown that similar crystalline rocks from supposed stratigraphical evidence came to be referred to formations of very different ages in palæozoic or more recent geologic time. The author then detailed the course of study by which he had been led to question this notion; he showed that there was, according to Faure, no longer any evidence in the Alps in support of the view above noticed, that Sedgwick in England and Nicoll in Scotland had rejected the views of the palæozoic age of the crystalline schists regarded by Murchison as Cambrian and Silurian; and finally gave the observations by which he (the speaker) had satisfied himself that the crystalline rocks of the Green Mountains and the White Mountains, and their representatives alike in Quebec, New Brunswick, and in the Blue Ridge, were more ancient than the oldest Cambrian or primordial fossiliferous strata. He showed how folding, inversion, and faults had alike, in the Alps and in Scotland, led to the notion that these crystalline rocks were in many cases newer than the adjacent fossiliferous strata, and mentioned that the subject would be further illustrated by a paper on the geology of New Brunswick.

ON STAUROLITE CRYSTALS AND GREEN MOUNTAIN GNEISSES OF SILURIAN AGE.

By Professor J. D. DANA.

Prof. Dana has already published the fact alluded to by Percival, that crystals of staurolite are found in mica schist at Salisbury, Conn., underlying directly the Stockbridge limestone. Since then he has found them in Southern Canaan, and at a locality west of Housatonic River, but in this case the schist overlies the limestone. This staurolite also contains garnets. The Stockbridge limestone is admitted to be Lower Silurian. Prof. Dana is sure that the Canaan limestone is identical with that of Stockbridge. In any case there is no reason to doubt that the staurolites occur in the later part of the Lower Silurian age, and strong reason for believing that these schists are in age veritable Hudson River rocks. On this view the Hudson River or Cincinnati group in the Green Mountains—alike in Connecticut, Massachusetts, and Vermont—includes beds of quartzite, mica schist, cholritic mica slate, hydro-mica or talcose slate, well characterized gneiss and granitoid gneiss.

The order of these deposits at South Canaan, Tyringham, and Great Barrington was then given, and the following conclusion reached: The fact that quartzite, limestone and gneiss, or mica schist, here alternate with one another, is beyond question; and if I am right in the age of the deposits as above suggested, the alternations occur at the junction of the Trenton and Hudson River formations. Other particulars respecting the geology of the region referred to were given in Prof. Dana's paper, and the conclusions reached that all old-looking Green Mountain gneisses are not pre-silurian; and further, that the presence of staurolite is no evidence of pre-silurian age.

ON CIRCLES OF DEPOSITION IN SEDIMENTARY STRATA.

By PROF. J. S. NEWBERRY of Columbia College, New York.

The different strata which compose the geological column have been divided into several groups, or systems, of which the base is formed by the old crystalline rocks called Laurentian and Huronian. On these rest the Lower Silurian System, composed of the Potsdam sandstone, the Calciferous sandrock, the Trenton group of limestones, and the Hudson group; the latter forming the summit of the Lower Silurian System. The Upper Silurian System has at its base the Medina sandstone; above this lie in succession the Clinton, the Niagara, and the Helderberg groups.

The Devonian system consists, in like manner, of the Oriskany sandstone, the Schoharie grit, the Corniferous limestone, and the Hamilton group. The carboniferous system, as Prof. Newberry claims, should begin with the Portage and Chemung, above which are the Waverley, the Carboniferous Limestone, and the Coal Measures. Now, if we compare these systems we shall see that they consist of circles of deposition, first, sandstone, viz.; the Potsdam, the Medina, the Oriskany, and the Portage; second mixed, mechanical, and organic sediments, viz., the Calciferous, the Clinton, the Schoharie and the Waverley.

The third member of each group is a limestone, viz., the Trenton, the Niagara, the Corniferous and the Carboniferous limestone. The fourth member of each group is a mixture of mechanical and organic sediments, viz., the Hudson, the Helderberg, the Hamilton and the Coal Measures. Prof. Newberry claimed that each of the circles of sediments was formed by an invasion of the land by the sea, producing, first a sheet of sea-beach sand and gravel; second, the off-shore deposits following and covering the first; third, the open sea calcareous, organic deposits—a limestone; fourth, a mixed sediment—shale and limestone, or an earthy limestone—the product of the retreating sea. Between these submergences perhaps millions of years elapsed, in which the fauna of the sea and the flora of the land were changed. Hence the different fossils of the different systems.

THE PROXIMATE FUTURE OF NIAGARA.

By Prof. G. W. Holley.

Prof. Tyndall said that if the rate of recession named by Sir C. Leyell, a foot a year, was correct, in 5,000 years the Horseshoe Falls would be far above Goat Island, and the American channel would be dry. Prof. Holley showed that Sir Charles's rate was the result of a conjecture founded on a guess. He also, by means of the most trustworthy data we have since the commencement of the historic period, showed that it would be more than twice that length of time before the falls would recede a mile.

He further described the formation of the bottom of the river, the course and depth of the different currents and the location of the bars, all which indicated that the American channel would never be without water.

Prof. Tyndall thinks that the depth of the water will determine the course of the chasm channel as the gorge recedes, and the rate of excavation. Prof Holley cited the physical facts which tend to prove that it is the character of the bed of the river, the harder or softer nature of the material to be broken down, that will decide these points. He particularly noticed the fact that the Falls were constantly diminishing in height as they receded, until they reached their present site, where the river makes an acute angle with its former direction. This was necessarily the case, because they were receding in the line of the dip of the underlying rock. They are now rising on the dip, and will be 50 feet higher than now when they are two miles up stream. To this bend in the river we owe one of the most beautiful features of the great cataract—the rapids above the Falls.

Prof. Tyndall speaks of his trip through the Cave of the Winds and of seeing the shale in it; also of the "blinding hurricane of spray which was hurled against him." Prof. Holley said it was this last circumstance which probably prevented Prof. Tyndall from noticing the fact that no shale whatever is visible in the cave. Prof. Holley closed by saying that Prof. Tyndall's style was so vigorous, animated, and positive that one might be excused if he preferred to read Tyndall's romances rather than the most realistic utterances of many of his brother scientists.

NEW THEORY OF GEYSER ACTION AS ILLUSTRATED BY AN ARTIFICIAL GEYSER.

By Edmund Andrews.

This paper stated Bunsen's theory of geysers as illustrated by Tyndall's apparatus, and showed the objections to this theory, the phenomena not corresponding to those of the natural geysers. The theory advocated in Mr. Andrews' paper is, that as the cooler waters of the surrounding country make their way into and through the caverns of the region of heated rocks, it will sometimes happen that the channel of supply will enter a cavern at a point higher than that where the channel of exit leaves it. If, now, this channel of supply has, like many other subterranean water-courses, some portion of its course much lower than the point of its entry into the cavern, we have all the main conditions necessary for a geyser. Suppose that all these caverns and passages are full of water, the rocks of the cavern heated, and with, perhaps, the addition of superheated steam from lower crevices. The pressure of steam accumulating in the top of the cavern will resist the further supply of cool water from the supply channel, and perhaps force it back to a point where the hydrostatic pressure of the column balances the pressure of the steam, which meanwhile accumulates sufficiently to force out the water in a jet into the external air. While the water in the cavern is above the orifice of exit, the jet will consist only of water, but when the cavern is emptied to the level of the outlet pipe, the steam will escape and relieve the pressure. Then the cool water of the supply channel, rushing in without resistance, cools the cavern and fills it, preparatory to a new eruption, when the water is again heated to boiling point. Diagrams of the natural geyser and of an artificial one, constructed to illustrate it, were exhibited and explained.

THE CHEMICAL COMPOSITION OF A COPPER MATTE.

By Prof. T. Sterry Hunt.

The name of matte or regulus is given to a product obtained in smelting partly roasted sulphuretted copper ores, and consisting in great part of sulphur and copper. It is the result of a process of concentration. A specimen of this, holding 45 per cent. of copper, beside iron and sulphur, was found to give up the greater part of its iron to dilute acids, with the escape of free hydrogen and sulphuretted hydrogen gases. It precipitated metallic copper and metallic lead abundantly from their solution, and contained apparently the greater part of its iron in a metallic state. When oxidised by nitric acid or bromine, it left a residue of more than ten per cent. of grains of pure magnetic oxide of iron, and the dissolved portion contained about thirteen equivalents each of copper and sulphur, beside eight of iron and a little zinc. It was, as might be expected, strongly magnetic.

The author insisted upon the apparent anomaly exhibited in the association in a furnace product of a stable oxide of iron in presence of a sulphuret, the affinities being curiously balanced in the fused mass. The presence of metallic iron at the same time he explained as the result of a partial dissociation of the double sulphuret on cooling. His inquiries in this matter are not yet finished, but throw an unexpected light on some furnace reactions, as the treatment of iron in the Bessemer process, and also on the production in nature of many igneous rocks.

EMBRYOLOGY OF LIMULUS, WITH NOTES ON THE AFFINITIES.

By A. S. Packard, M.D.

In a recent paper on the embryology of Limulus, published in the memoirs of the Boston Society of Natural History, I stated that the blastodermic skin just before being moulted consisted of nucleated cells; and also traced its homology into the so-called amnion of insects. I have this summer, by making transverse sections of the egg, been able to observe in a still more satisfactory manner these blastodermic cells and observe their nuclei before they become effaced during or after the blastodermic moult.

On June 17 (the eggs having been laid May 27) the peripheral blastodermic cells began to harden, and the outer layer—that destined to form the amnion—to peel off from the primitive band beneath. The moult is accomplished by the flattened cells of the blastodermic skin hardening and peeling off from those beneath; during this process the cells in this outer layer losing their nuclei, and, as it were, drying up, contracting and hardening during the process. This blastodermic moult is comparable with that of Apus, as I have already observed, the cells of the blastodermic skin in that animal being nucleated.

The paper set forth that while the process above described resembled features in the development of the scorpion, and thus strengthened the supposition of Burmeister, that the Limulus is related to the spiders, nevertheless other features which Prof. Packard pointed out led him to believe that the Limulus is related to the lower crustaceans, but is, like all the earlier or palæozoic types, comprehensive or synthetic, comprising certain features belonging to higher forms, while yet holding its proper affinities with the lower ones. He also confirmed the brilliant researches of A. Milne Edwards upon this representative of an ancient type.

GENITALIA AND EMBRYOLOGY OF THE BRACHIOPODA.

By Prof. Edward S. Morse, of Salem, Mass.

The papers read on this subject by Prof. E. S. Morse, of Salem, Mass, showed that the brachiopods were the only class of animals of which the developmental history has been hitherto unknown. So dark has been this department of zoölogy, that an eminent German naturalist, Oscar Schmidt, published but a single figure of a young brachiopod as an important contribution to existing knowledge. Lacaze-Duthier had been the only one to give a few figures of an embryo brachiopod until Prof. Morse last year contributed sketches of a native species, confirming the investigations of the French naturalist.

Before going further it may be well to give unscientific readers a notion of what kind of an animal the brachiopod is, and why so great interest centres upon this group. One of Cuvier's memoirs, as early as 1802, was upon one of this class of animals. Hancock and Davidson of England have each received gold medals from the Royal Society for their contributions on this subject. Eminent German naturalists have written memoirs upon it. Prof. Huxley has made it the subject of special study. The reason for this peculiar interest among naturalists is that the very earliest fossiliferous remains—those deposited in the most ancient rocks—are members of this class. They are moreover found in rocks of all subsequent ages, and are still living in the seas of the present day. Singularly enough, while all other groups of animals have changed in their distinctive features, and many have become extinct, there are brachiopods of the present day that can scarcely be distinguished from their most ancient representatives. They are a closed type, having no branches, and may be therefore considered as a royal family among animals, their line of descent having been unbroken and untainted since the very dawn of life. But like other ancient families, their numbers have seriously diminished, and their line is probably in process of extinction.

The brachiopod is a small animal, enclosed in a bivalve shell, and adhering by a posterior appendage to the ocean floor The possession of this bivalve shell has led all naturalists to include brachiopods among the mollusks. Three years ago Prof. Morse after a long and patient study of the living forms, startled the world of naturalists by announcing his conviction that the animals were not mollusks, and that they had no relations with shell fish whatever, but were true worms. Radical as was this innovation in classification, it received the sanction of several eminent naturalists, both at home and abroad. But before this new view could secure general acceptance, it was necessary that the obscure and almost unknown history of the animal from the egg to the adult should be fully ascertained. This Prof. Morse has at last accomplished. He has succeeded in raising the brachiopod from the egg and has studied its internal and external structure in every stage of growth. So to speak, he has seen it in its infancy and childhood, and dissected every portion of it under the microscope, drawing, as he can, with one hand and writing a description with the other, while his eye was glued to the instrument.

Briefly then, the embryo commences life as a little worm of four segments, and after enjoying itself in swimming freely in the water for a while, attaches itself to the sea bottom by its posterior segment, and settles permanently. The middle segment then protrudes on each side of the head segment, and gradually incloses it, thus producing the dorsal and ventral shell so characteristic of the entire class. This unlooked for, simple development could not have been predicated by any study of the adult animal, but remarkably sustains the homologies insisted upon two years ago by Prof. Morse in his papers upon the subject. The present communication elicited warm approbation.

ON SOME EXTINCT TYPES OF HORNED PERISSODACTYLES.

By Prof. Edward D. Cope, of Philadelphia.

It is well known that the type of *Mammalia* of the present period, which is preëminently characterised by the presence of osseous horns, is that of the *Artyodactyla Ruminantia*. At the meeting of the Association of last year, held at Dubuque, I announced that the horned mammals of our Eocene period were most nearly allied to the Proboscidians. I now wish to record the fact, as I believe for the first time, that the Perissodactyles of the intermediate formation of the Miocene embraced several genera and species of horned giants not very unlike the *Loxolophodon* and *Uintatherium* in their horned armature.

While exploring in connection with the United States Geological Survey of the Territories, I discovered a deposit of the remains of numerous individuals of the above character, which included among other portions crania in a moderately good state of preservation. Most of these skulls are nearly or quite three feet in length, and mostly deprived of their mandibular portions; these are quite abundant in a separated condition. The crania represent at least three species, while the mandible presents a condition distinct from that of *Titanotherium* or any allied genus. The teeth diminish rapidly in size anteriorly, and there is no diastema behind the canines, whose conic crowns do not exceed those of the premolars in length. To the genus and species thus characterized I have elsewhere given the name of *Symborodon torvus*.

One of the crania, referred to under the name of *Miobasileus ophagus*, is characterized by its strong and convex nasal bones and concave superior outline posteriorily, and by the presence of a massive horn-core on each side of the front whose outer face is continuous with the inner wall of the orbit, precisely as in the *Loxolophodon cornutus*. It stood above the eye in life, and diverged from its fellow so as to overhang it. In the specimen, which was fully adult, they were worn obtuse by use—length, about eight inches; thickness, three inches. The molar teeth differ from those of *Titanotherium Proutii* in having cross crests extending inward from the apices of the outer chevrons, each of which dilates into a T-shape near the cones.

The third species is for the present referred to *Megaceratops*, under the name of *M. acer*. It has overhanging eye-brows and the vertex little concave, but the nasal bones are greatly strengthened, and support on each side near the apex a large curved horn core of ten inches in length with sharply compressed apex. These bones diverge with an outward and backward curve, and when covered with their sheaths must have considerably exceeded a foot in length. This was a truly formidable monster, considerably exceeding the Indian rhinoceros in size.

The fourth species is allied to the last, and has well developed superciliary crests without horns. The latter are situated well anteriorly, and are short tubercles not more than three inches in height. They are directed outward, and have a truncate extremity. The type individual is of rather larger size than those of the other species. There are several crania referable to the three now named. The present one has been named *Megaceratops hiloceros*.

It was thought probable that some of the species based upon crania would be found to belong to the genus *Symborodon*.

These animals show true characters of the *Perissodactyla* in their deeply excavated palate, solid odontoid process, third trochanter of femur, which has also a pit for the round ligament, in the divided superior ginglymus of the astragalus, etc.

ON A SIGILLARIA SHOWING MARKS OF FRUCTIFICATION.

By J. W. Dawson, L.L.D.

The speaker explained in detail the nature of the leaf-scars and marks of growth of this remarkable tree of the coal formation, and then proceeded to describe the scars left on the specimen in question, which showed the girdles of scars left by the fall of the fruit. He showed that this could not have been of the nature of strobiles or cones, but must have been borne on separate modified leaves after the manner of some Cycads. The specimen belonged to a new species soon to be described by him, and closely allied to *S. Lalayana* of Schimper.

ON THE QUESTION "DO SNAKES SWALLOW THEIR YOUNG?"

By G. Brown Goode, of Middletown University, Conn.

This paper discussed the habit observed in certain snakes of allowing their young a temporary refuge in their throats, whence they emerge when danger is past. He stated that the question had been a mooted one since the habit was first discussed by Gilbert White in his "Natural History of Selborne," published in 1789. Reference was made to the views of Sir William Jardine, M. C. Cooke and Prof. F. W. Putnam, as well as the recent discussion of the subject in *Land and Water*.

The question can only be decided by the testimonies of eyewitnesses. Through the courtesy of the editors of *The American Agriculturist* a note was inserted asking for observations. By this means and by personal inquiry the testimony of 96 persons had been secured. Of these 56 saw the young enter the parent's mouth, in 19 cases the parent warning them by a loud whistle. Two were considerate enough to wait and see the young appear when danger seemed to be past, one repairing to the same spot and witnessing the same act on several successive days. Four saw the young rush out when the parent was struck; 18 saw the young shaken out by dogs or running from the mouth of their dead parent; 29 who saw the young enter, killed the mother and found them living within, while only 13 allowed the poor parent to escape; 27 saw the young living within the parent. But as they did not see them enter, the testimony is at least dubious.

It may be objected that these are the testimonies of laymen, untrained and unaccustomed to observation. The letters are, however, from a very intelligent class of farmers, planters, and business men—intelligent readers of an agricultural magazine. In addition, we have the testimony of several gentlemen whose word would not be doubted on other questions in zoölogy. There were given the statements of Prof. S. I. Smith of Yale College, Dr. Edward Palmer of the Smithsonian Institute, the Rev. C. L. Loomis, M.D., of Middletown, Conn., and others; and the statement of the editor of *The Zoölogist* regarding the Scaly Lizard of Europe (*Zoötoca vivipara*), which has a similar habit.

In the opinion of Profs. Wyman and Gill and other physiologists, there is no physical reason why the young snakes may not remain a considerable time in the dilatable throat and stomach of the mother. The gastric juice acts very feebly upon living tissues, and it is almost impossible to smother reptiles. Toads and frogs often escape unharmed from the stomach of snakes. If the habit is not protective, if the young cannot escape from their hiding place, this habit is without parallel; if it is protective, a similar habit is seen in South American fishes of the genera *Arius*, *Bagrus*, and *Geophagus*, where the male carry the eggs for safety in their mouths and gill-openings.

Since many important facts in biology are accepted on the statements of a single observer, it is claimed that these testimonies are sufficient to set this matter forever at rest. The well attested cases relate to the garter snake and ribbon snake (*Eutania sirtalis* and *saurita*), the water snake (*Tropidonotus sipedon*), the rattlesnake (*Caudisona horrida*), the copperhead and moccassin (*Agkistrodon contortrix* and *piscivorus*), the massasauga (*Crotalus tergeminus*), the English viper (*Pelias berus*), and the mountain black snake (*Coluber Alleghaniensis*). It is probable that the habit extends through all the species of the genera represented, as well as throughout the family of *Crotalidæ*. It is noteworthy that all these snakes are known to be ovoviviparous, while no well attested case occurs among the truly oviparous, milk snakes (*Ophibolus*), grass snakes (*Liopeltis* and *Cyclophis*), ground snakes (*Storeria*), or the smooth black snakes (*Bascanion constrictor*). It yet remains to be shown that the habit is shared by egg-laying snakes. Further observations are much needed, as the breeding habits of more than 25 North American genera are entirely unknown

NOTES ON PROTOTAXITES.

Mr. Carruthers, of the British Museum, having published in the "Monthly Microscopical Journal," some criticisms on *Prototaxites Logani* from the Devonian of Gaspé, which he argues may have been a gigantic sea-weed, Principal Dawson replies in the same Journal. The following abstract of the reasons for regarding Prototaxites as a conifer is deserving of publication here, as the species was first noticed in this Journal.

1. *Mode of Occurrence.*—This alone should suffice to convince any practical palæontologist that the plant cannot be a sea-weed. Its large dimensions, one specimen found at Gaspé Bay being three feet in diameter; its sending forth strong lateral branches, and gnarled roots; its occurence with land plants in beds where there are no marine organisms, and which must have been deposited in water too shallow to render possible the existence of the large oceanic Algæ to which Mr. Carruthers likens the plant. These are all conditions requiring us to suppose that the plant grew on the land. Further, the trunks are preserved in sandstone, retaining their rotundity of form even when prostrate; and are thoroughly penetrated with silica except the thin coaly bark. Not only are Algæ incapable of occurring in this way, but even the less dense and durable land plants, as Sigillariæ and Lepidodendra are never found thus preserved. Only the extremely durable trunks of coniferous trees are capable of preservation under such circumstances. In the very beds in which these occur, *Lepidodendra*, tree ferns and *Psilophyton*, are flattened into mere coaly films. This absolutely proves, to any one having experience in the mode of occurrence of fossil plants, that here we have to deal with a strong and durable woody plant.

2. *Microscopic Structure.*—It would be tedious to go into the numerous scarcely relevant points which Mr. Carruthers raises on this subject. I may say in general that his errors arise from neglect to observe that he has to deal not with a recent but a fossil wood, that this wood belongs to a time when very generalized and humble types of gymnosperms existed, and that the affinities of the plant are to be sought with Taxineæ, and especially with fossil Taxineæ, rather than with ordinary pines.

Mr. C., after describing Prototaxites according to his own views of its structure, expresses the opinion that "the merest tyro in histological botany" may see that the plant could not be phænogamous. But if the said tyro will take the trouble to refer to the beautiful memoir on the Devonian of Thuringia, by Richter and Unger,* and to study the figures and descriptions of *Aporoxylon primigenium*,† *Stigmaria annularis*, *Calamopteris debilis*, and *Calamosyrinx Devonicus*, he will find that there are Devonian plants referred by those eminent palæontologists to Gymnosperms and higher Cryptogams, which fall as far short of Mr. Carruthers' standard as Prototaxites itself. Nothing can be more fallacious in fossil botany than comparisons which overlook the structures of those primitive palæozoic trees which in so many interesting ways connect our modern gymnosperms with the cryptogams.

It is scarcely necessary to reply to such a statement as that the fibres of Prototaxites have no visible terminations. They are very long, no doubt, and both in this and their lax coherence they conform to the type of the yews. In Mesozoic specimens of *Taxoxylon* which I have now before me, the fibres are nearly as loosly attached and as round in cross section as in Prototaxites. In these, as in Prototaxites, water-soakage has contributed to make the naturally lax and tough yew-structure less compact, and to produce that appearance of thickness of the walls of the fibres which is so common in fossil woods.

Disks or bordered pores in Prototaxites I did not insist on, the appearance being somewhat obscure; but Mr. Carruthers need not taunt me with affirming the existence of such pores in the walls of cells not in contact. Pores, if not bordered pores, may exist on such cells, and the wood cells of Prototaxites are in contact in many places, as may easily be seen, and even where they appear separate, this separation may be an effect of partial decay of the tissues.

Mr. Carruthers converts the spiral fibres lining the cells of Prototaxites into tubes connecting the cells. This is a question of fact and vision, and I can only say that to me they appear to be solid, highly refracting fibres; and under high powers, precisely similar to those of fossil specimens of Taxoxylon from

* Trans., Vienna Academy, 1856.

† I have elsewhere compared Aporoxylon with Prototaxites, 'Jour. Geol. Soc.' 1862, p. 306. Report on Devonian plants.

British Columbia, and to those seen in charred slices of modern yews. I may further say that Mr. Carruthers' figure is in my judgment to a great extent imaginary.

But what of the arrangement of these fibres. It is true that, as I have stated, they appear in some cases to pass from cell to cell, and I hesitated to account for this appearance. The possibilities of such an appearance, as yet, perhaps, unknown in the plant-rooms of the Museum, result from the following considerations: (1.) In more or less crushed fossil plants, it is not unusual to see what are really internal structures appearing to pass beyond the limits of the cell-wall, from the mere overlapping of cells. I have good examples in the Mesozoic Taxoxylon already mentioned. (2.) In fossil woods the original cell-wall is often entirely destroyed, and only the ligneous lining remains, perhaps thickened by incrustation of mineral matter within. In this case the original lining of the cell may seem to be an external structure. I have examples both in Mesozoic conifers and in carboniferous plants. Long soaking in water and decay have thus often made what may have been a lining of wood-cells appear as an intercellular matter, or an external thickening of the walls. (3.) In decayed woods the mycelium of fungi often wanders through the tissues in a manner very perplexing; and I suspect, though I cannot be certain of this, that some fossil woods have been disorganized in this way. At the time when my description was published, I felt uncertain to which of these causes to attribute the peculiar appearance of Prototaxites. I have now, from subsequent study of the cretaceous Taxineæ of British Columbia,* little hesitation in adopting the first and second explanations, or one of them, as probable.

Mr. Carruthers does not believe in the medullary rays of Prototaxites. The evidence of these is the occurrence of regular lenticular spaces in the tangential section, which appear as radiating lines in the transverse section. The tissues have perished; but some tissues must have occupied these spaces; and in fossil woods the medullary rays have often been removed by decay, as one sometimes sees to be the case with modern woods in a partially decayed state. Mr. Carruthers should have been more cautious in this matter, after his rash denial, on similar grounds, of me-

* Report of Geol. Survey of Canada, now in course of publication. The collections contain wood showing the structure of yew, cypress, oak, birch, and poplar, all from rocks of cretaceous age.

dullary rays in Sigillaria and Stigmaria, contrary to the testimony of Brongniart, Goeppert, and the writer, and the recent exposure of his error by Professor Williamson. That the wood-cells have been in part crushed into the spaces left by the medullary rays is only a natural consequence of decay. The fact that the medullary rays have decayed, leaving the wood so well preserved, is a strong evidence for the durability of the latter. The approval with which Mr. C. quotes from Mr. Archer, of Dublin, the naïve statement that "the appearance of medullary rays was probably produced by accidental cracks or fissures," would almost seem to imply that neither gentlemen is aware that radiating fissures in decaying exogenous woods are a consequence of the existence of medullary rays, [or that water-soaked wood cannot be cracked in this way.]

Perhaps the grossest of all Mr. Carruthers' histological errors is his affirming that some of my specimens of Prototaxites show merely cellular structures, or are, as he says, "made up of spherical cells." Now, I affirm that in all my specimens the distinct fibrous structure of Prototaxites occurs, but that in parts of the larger trunks, as is usual with fossil woods, it has been replaced by concretionary structure, or by that pseudo-cellular structure which proceeds from the formation of granular crystals of silica in the midst of the tissues. Incredible though it may appear, I know it to be a fact, as all the specimens I gave to Mr. Carruthers had been sliced and studied by myself, that it is this crystalline structure which the botanist of the British Museum mistakes for vegetable cells.* I think it right to state here that I not only gave Mr. C. specimens in these different states of preservation, but that I explained to him their nature and origin.

3. *Affinities.*—In discussing these I must repeat that we must bear in mind with what we have to deal. It is not a modern plant, but a contemporary of that "prototype of gymnosperms" *Aporoxylon*, and similar plants of the Devonian. Further, the comparison should be not with exogens in general, or conifers in general, but with Taxineæ, and especially with the more ancient types of these. Still further, it must be made with such wood partly altered by water-soakage and decay and fossilized. These

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* In fossil-woods, the carbonaceous matter, being reduced to a pulpy mass, sometimes partly becomes moulded on the surfaces of hexagonal or granular crystals, in such a manner as to deceive very readily an observer not aware of this circumstance.

necessary preliminaries to the question appear to have been altogether overlooked by Mr. Carruthers.

My original determination of the probable affinities of Prototaxites, as a very elementary type of taxine tree, was based on the habit of growth of the plant—its fibrous structure, its spirally-lined fibres, its medullary rays, its rings of growth, and its coaly bark, along with the durable character of its wood, and its mode of occurrence; and I made reference for comparison to other Devonian woods and to fossil taxine-trees.

Mr. Carruthers prefers to compare the plant as to *structure* with certain chlorospermous Algæ, and as to *size* with certain gigantic Melanosperms, not pretended to show similar structure. This is obviously a not very scientific way of establishing affinities. But let us take his grounds separately. He selects the little jointed calcareous sea-weed *Halimeda opuntia*, as an allied structure, and copies from Kutzing a scarcely accurate figure of the tissue of the plant as seen after the removal of its calcareous matter.* He further gives a defective description of this structure; whether taken from his own observation or from Kutzing, he does not say. Harvey's description, which I verified several years ago, in an extensive series of examinations of these calcareous Algæ, undertaken in consequenceof a suggestion that Eozoön might have been an organism of this nature, is as follows:—"After the calcareous matter of the frond has been removed by acid a spongy vegetable structure remains made up of a plexus of slender longitudinal unicellular filaments constricted at intervals, and at the constrictions emitting a pair of opposite decompound, dichotomous, corymboso-fastigiate horizontal ramelli, whose apices cohere and form a thin epidermal or peripheric stratum of cells." It will be seen at once that this structure has no resemblance whatever to anything existing in Prototaxites, even as interpreted by Mr. C., and without taking into account the fact that *Halimeda opuntia* is a small calcareous sea-weed, divided into flat reniform articulations, to which this structure is obviously suited, as it would be equally obviously unsuited to the requirements of a thick cylindrical trunk, not coated with calcareous matter.

In point of size, on the other hand, Mr. Carruthers adduces the great *Lessonia* of the Antarctic seas, whose structure, how-

* A more characteristic [illegible] ven in Harvey's "North American Algæ."

ever, is not pretended to resemble that of Prototaxites except in the vague statement of a pseudo-exogenous growth. *Lessonia* I have not examined, but the horny *Laminariæ* of our North American seas have no resemblance in structure to Prototaxites.

Nothing further, I think, need be said in reply to Mr. Carruthers' objections; and *Nematophycus* may be allowed to take its place along with a multitude of obsolete fucoids which strew the path of palæontology. As to Prototaxites, it is confessedly an obscure and mysterious form, whose affinities are to be discussed with caution, and with a due consideration of its venerable age and state of preservation, and probably great divergence from any of our modern plants; and it is to be hoped that ere long other parts than its trunk may be discovered to throw light on its nature. Until that takes place, the above remarks will be sufficient to define my position in regard to it; and I shall decline any further controversy on the subject until the progress of discovery reveals the foliage or the fruit of this ancient tree, belonging to a type which I believe passed away before even the Carboniferous flora came into existence.

GEOLOGY AND MINERALOGY.

Bone Cave in Kirkcudbrightshire.—It has long been familiar to geologists that the western and southern coast-line of Scotland is pierced with caves of different levels, indicating former successive lines along which the sea-waves worked. Unfortunately, owing to the want of limestone, or very calcareous rocks, these caves, as a rule, present none of that stalagmite deposit which has elsewhere served so abundantly to cover over and preserve the remains of the ancient denizens of our country, with traces of the presence of man himself. The caves usually open directly upon the coast, with free exposure to the air, so that the floors show nothing but damp boulders and pools of water from the drip of the roof. Recently, however, a remarkable exception to these ordinary conditions has been observed on the wild cliff-line to the south-west of the bay of Kirkcudbright. The Silurian greywacke is there traversed with strings and veins of calcite along lines of joint and fracture, and at one point where an old sea cave occurs, the walls and floor at the cave mouth, and for a few yards inwards, have a coating of solid calcareous matter. Beneath this coating in the substance of the breccia which extends across the cave mouth, as well as throughout the cave earth behind the breccia, a great quantity of bones, with traces of human occupation, have been found. A systematic investigation of the cave, commenced last autumn, is being carried on under the direction of Mr. A. J. Corrie and Mr. W. Bruce-Clarke—the discoverers of the osseous layer. At the present time the following among other remains have been noted: bones of ox, red deer, goat, horse, pig, pine-marten, rabbit, watervole, and other small rodents, together with numerous remains of birds and a few frog and fish bones. Intermingled with these occur fragments of bronze, bone needles, and other bone implements, to the number of more than twenty; one piece of worked stone (a fragment of greywacke) has been found, but as yet not a single chip of flint. A full account of the cave will be published as soon as the investigations are completed.—*Geological Magazine.*

FOSSILS OF THE LOWER POTSDAM ROCKS AT TROY, N. Y.—In the August number of the American Journal of Science, Mr. S. W. Ford gives a list of the fossils found in these rocks, including several which he considers as new—*Microdiscus speciosus, Leperditia Troyensis*, and a bivalve of uncertain affinities. Judging from its fauna he concludes that the Troy series of rocks is of nearly if not exactly the same age as the Olenellus or Georgia slates of Vermont, and the Olenellus limestones on the north shore of the Straits of Belle Isle. The fauna is quite distinct specifically from that of the Upper Potsdam of Wisconsin and the true Potsdam of New York, as well as from that of the more ancient St. John's or Menevian group of New Brunswick and its equivalent in the Primordial of Newfoundland; but is connected with each of them generically.

SAPONITE.—This mineral occurs in cavities in the trap of George or Hog Island, a small island in Richmond Bay, on the north coast of Prince Edward Island. It is grayish-white to grayish-green in color; subtranslucent before exposure to the air, but afterwards becoming opaque and white. Massive and very soft, but becoming brittle on drying. Sp. gr. 2.23—2.27. Before the blowpipe becomes opaque and fuses at about 4. In the closed tube gives off water. Decomposed by sulphuric acid. The following is the mean of two analyses:

Silica	43.91
Alumina	6.47
Peroxide of Iron	1.23
Lime	.59
Magnesia	27.18
Water	19.64
	99.02

B. J. H.

PHOSPHATIC CHARACTER OF THE SHELLS OF OBOLUS.—Analyses by A. Kupffer show that the shells of Lower Silurian *Obolus* have nearly the composition of a fluor-apatite. He obtained from a specimen from Jamburg in Ehstlands,

PO_5	CO_2	Fl	Fe_2O_3	MgO	CaO	ign.	quartz	
36.57	2.42	3.31	4.90	0.62	50.47	2.57	0.53	= 101.39

from which, deducting the oxygen in excess, on account of the fluorine, 1.59, leaves 99.80.

A concretion of Trilobite shells contained, according to the same chemist, PO_5 19,45, CaO 45.06, CO_2 16.45, Fl 2.88, with a little FeO, MgO, and 6.80 of volatile matters mainly bituminous, corresponding to 42.46 phosphate of lime, 31.81 carbonate, 5.91 fluorid of calcium, with some carbonate of iron and other impurities.—*Am. Jour. Sc.*

BOTANY AND ZOOLOGY.

THE FERTILIZATION OF GRASSES.—Prof. Hildebrand, a German botanist who has paid great attention to the subject of the fertilization of flowering plants, has recently made an important series of observations on the fertilization of grasses, and especially of cereals. The agent of fertilization in all grasses, except those few in which the flowers never open, is the wind, insects apparently playing no part in it. With this object the pollen grains are very fine and smooth, so that they are at once dispersed by a breath of air; the filaments are usually not stiff, but versatile, and the stigma is either feathery, or presents a large surface with numerous indentations in which the pollen is easily lodged. These contrivances render cross-fertilization inevitable; and, while self fertilization is in most cases not absolutely prevented, it is generally rendered very difficult. Many species, however, which are ordinarily cross-fertilized never open their flowers when the weather is cold and rainy, and are, in such circumstances, necessarily self-fertilized. In grasses with unisexual flowers, cross-fertilization must take place as a matter of course. In those with hermaphrodite flowers a few are protogynous, and hence also necessarily cross-fertilized. In the larger number of grasses, however, the male and female organs are developed at the same time, and special contrivances occur for ensuring cross-fertilization. In the rye the position of the organs is such that a part of the pollen from one flower must almost necessarily fall on the stigma of another flower. In the wheat each separate flower remains open only for an extremely short time, the glumes separate from one another suddenly, the anthers immediately protruding, and a large quantity of the pollen is dispersed into the air, the whole process not occupying more than half a minute. In most of these cases the stigma remains receptive only for a very short period and then dies, while in others the stigma remains in a receptive condition till long after the anthers have dropped off, and then must necessarily be open to the access of foreign pollen. In comparatively few cases the natural contrivances appear to favor self- rather than cross-fertilization. Thus in the oat and barley the majority of the flowers never open, and are, therefore, necessarily self-fertilized; there appear, however, in almost all cases to be a small number of flowers, often arranged in one or two separate rows, which do open, and therefore may introduce occasional cross-fertilization. It is probable that the same species behaves differently in relation to its arrangements for fertilization under different circumstances of climate, while species very nearly related exhibit phenomena which offer a marked contrast.—*American Naturalist.*

SPHAGNUM AND HYPNUM PEAT.—The opinion seems to have been somewhat prevalent that peat does not accumulate abundantly in limestone regions, but this is not true of large portions of some of the northern interior states. For example, all the peat of Iowa is in an eminently limestone region, and the water taken out of any of the marshes shows a strong reaction for lime by proper chemical tests.

From my own observations I believe that Sphagnum peat does not accumulate in limestone regions, but that the peat mosses of such regions all belong to the genus Hypnum. I have found no other moss entering into the composition of Iowa peat.

Another fact observed in this connection has doubtless much significance, namely, the Ericaceæ are almost entirely wanting in Iowa, and no plants of that order have yet been observed by myself in or about these Hypnum marshes. The principal plant assisting the Hypnum in the production of peat is a kind of grass.

Should one go north from Iowa or Illinois into the metamorphic regions of Minnesota and Wisconsin, I think he would see the Hypnum gradually give place to Sphagnum in the marshes, and the marsh Ericaceæ appear with the last named moss.

In short, lime seems to be an uncongenial element in the habitat of both Sphagnum and most if not all ericaceous plants, but is not uncongenial to Hypnum and grass. Therefore the abundant presence of lime will not necessarily prevent the accumulation of peat.—*Ibid.*

Circulation in the King Crab.—M. Alphonse Milne-Edwards finds that the circulating apparatus of Limulus is more perfect and complicated than that of any other articulate animal. The venous blood, instead of being diffused through interorganic lacunæ, as in the crustacea, is, for a considerable portion of its course, enclosed in proper vessels with walls perfectly distinct from the adjacent organs, originating frequently by ramifications of remarkable delicacy, and opening into reservoirs which are for the most part well circumbscribed. The nutritive liquid passes from these reservoirs into the branchiæ, and, after having traversed these respiratory organs, arrives by a system of branchio-cardiac canals, in a pericardiac chamber, then penetrates into the heart, of which the dimensions are very considerable. It is then driven into tubular arteries with resistant walls, the arrangement of which is exceedingly complex, with frequent anastomoses, and of which the terminal ramifications are of marvellous tenuity and abundance. He has also found, as Prof. Owen had intimated, that the nerves are completely ensheathed by the blood vessels. —*Annals and Mag. Nat. History.*

In the *Chronique de la Société d'Acclimatation*, M. Ruimet states that by feeding silk-worms on vine-leaves he has obtained silk of a fine red colour; and that by giving the worms lettuce-leaves, they have produced cocoons of an emerald-green colour. M. Delidon de St. Gilles, of Vendée, has also, by feeding silk-worms—during the last twenty days of the larva period—on vine, lettuce, and nettle-leaves, obtained green, yellow, and violet cocoons.—*Athenæum.*

A collection of freshwater fishes, made at Shanghai by H.M. Consul, Mr. R. Swinhoe, has been reported on by Dr. A. Günther, of the British Museum. The collection is notable for containing an unusually large proportion of new species, or such as have hitherto been but imperfectly known.—*Ibid.*

CHEMISTRY.

Synthesis of Marsh Gas and Formic Acid.—Sir B. C. Brodie has found that if a mixture of hydrogen and carbon oxide is submitted to the action of electricity in the induction tube, a contraction of volume ensues accompanied with the production of marsh-gas. The reaction is expressed by the equation—

$$CO + 3H_2 = C_4 + H_2O.$$

It was also found that on treating a mixture of carbon dioxide and hydrogen in a similar manner, the resultant gas contained carbon oxide, while minute drops of an oily liquid collected in the tube. These gave the characteristic reactions of formic acid, and their production may be represented by the equation—

$$H_2 + CO_2 = H_2 CO_2$$

Note on Silicic Acid.—C. Rammelsberg has found that silica which after a short ignition, dissolves in a boling solution of potassium or sodium carbonate, loses this property, either partly or almost entirely, when it is subjected to a more prolonged and stronger ignition. Hence when the silica obtained in analysis is to be dissolved in potassium or sodium carbonate, this operation should be performed before its ignition.

The author has made a series of determinations of the water contained in silica obtained by the decomposition of an alkaline silicate, or of Wollastonite, and finds that this substance, when dried over oil of vitrol, contains 4·5 to 7 per cent of water, and that when it is dried at 100° to 140°, it retains from 4 to 5·7 per cent. of water. These numbers correspond to hydrates nSiO + Aq, in which n lies between 4 and 8. Air-dried silica retains 13 to 36 per cent. of water. The latter of these numbers corresponds to SiO + 2aq, and the former to SiO_2 + Aq.

—*Jour. Chem. Soc.*

MISCELLANEOUS.

Professor Ward's Natural Science Establishment at Rochester, N. Y.—When Professor Agassiz gave his opening lecture in the Museum of Comparative Zoology at Cambridge in 1860, he said that American students had been forced to visit Europe if they were desirous of making any extended study in the natural sciences, but that he intended to reverse this and compel European students to visit America; and by his judicious purchase of type collections abroad (thanks to the liberality of citizens and our State) he has made his promise good.

Professor Henry A. Ward of Rochester, New York, formerly a student of Professor Agassiz, and since Professor of Geology and Zoology in the Rochester University, has, under humbler auspices, long been working toward the same end. His large cabinet of geology and mineralogy at Rochester is well known to many of our readers. He long ago felt the necessity of bringing before the American student examples of those larger and rarer fossils known to geological science, of which only single specimens existed.

For this purpose he visited Europe, engaged accomplished workmen and commenced the foundation of a collection of casts. With untiring patience and sagacity he secured the moulds of nearly everything of importance, at enormous expense, carrying his workmen from one museum to the other, and taking moulds of the choicest specimens, for a period of three years.

The difficulties encountered in some of his experiences would form an interesting chapter. After many difficulties, he managed to secure moulds of rare Megatherium, Glyptodon, Deinotherium, Diprotodon, Sivatherium, Colossochelys, Mosasaurus, Plesiosaurus, and many other unique specimens in European museums. Thorough and methodical in all his work, he felt that this collection of casts should be symmetrical and complete, as an educational collection, and so was commenced the famous Ward collection of casts. Thousands of dollars were spent in buying especially choice specimens of the obtainable forms solely for the purpose of making casts from them, and the originals are still preserved in his museum at Rochester. Every educational institution in the country may now possess perfect casts of the rarest fossils, forming exact facsimiles of the unique originals in the British Museum, the Jardin des Plantes, and other foreign museums, besides a representative collection of all that is needed to illustrate geological history.

From this important beginning, Professor Ward has gone on enlarging the usefulness of his work by adding to his stock, skins and skeletons of animals, fossils and minerals, and alchoholic specimens, so that institutions may provide themselves with collections accurately labelled and arranged, without sending abroad for the purpose.

With the capital invested in so large an enterprise, rapid sales must be effected, and one not familiar with the scientific attainments of Professor Ward, and the sole desire that animates him, to spread far and wide the type collections so important for educational purposes, might confound his occupation with that of the ordinary dealer in natural history objects, such as one may find in any large city. While in the latter case, however, with some laudable exceptions, the dealers offer simply the fortuitous gatherings of sailors, comprising curosities, shells, and detached portions of animals, like turtles' shields, sharks' jaws, and the like, of no intrinsic value, the work in which Prof. Ward is engaged is one of a solid scientific character. His outlays are immense, yet everything he does is done solely in reference to advancing science. He has the endorsement of every naturalist in the country, and already the leading museums in the country are indebted to him for some of their choicest material.

Every scientific man should visit Professor Ward's place at Rochester, New York, and see the bee-hive of industry he has built up around him. We visited Rochester in February, solely for the purpose of examining the new industry. Here one finds several large buildings, besides sheds and yards devoted to receiving, preparing and shipping specimens. There are twelve men constantly employed as taxidermists, osteologists, moulders and carpenters. Two of the osteologists he has brought from the Jardin des Plantes, Paris, where they had worked for a long time under the direction of eminent anatomists. The skeletons and skulls prepared here are beautiful in their whiteness and the elegance of their mounting. In the University building is Professor Ward's zoological cabinet, still his private property, containing type forms of the animal kingdom. This is carefully labelled and is strictly an educational collection.

In Cosmos Hall is a large room containing a large and valuable geological collection, particularly rich in Ammonites, fossil cuttle fishes, with the ink glands still preserved; beautiful fossil fishes from the Lias of England and Germany; fine Saurians in slabs; Icthyosaurus, Plesiosaurus, Teleosaurus; also the leg bones and other remains of the remarkable Dinornis from New Zealand; Mastodon and other mammal remains, and an almost perfect skeleton of the rare Glyptodon, the gigantic fossil armadillo.

Great interest attaches to this collection since it contains the original specimens of many of his casts, which have already a traditional value, now that so many institutions possess them. This series of *originals* is of intense interest, and will alone give tone and character to any geological cabinet in which they may be incorporated. In this room may also be seen relief maps and various models of geological import; many of these are familiar to College Professors through the descriptions and figures given in Ward's "Illustrated Catalogue." At the time of our visit he was packing a series of casts for the Syracuse University, and a Megatherium was being cast for Dartmouth College. A cast of the skeleton of this latter huge animal may be seen in the Geological Hall of the Smithsonian Institution at Washington, where it was placed by Professor Ward, and copies of it are already in several other museums together with other of his specimens. The series of casts have been invaluable in advancing the study of geology, as their possession is just as important to the instructor in this department, as the possessson of the manikin and skeleton is to the successful teaching of human anatomy.

The zoological portion of Professor Ward's establishment most interested us. Here all is on the same large scale. In bringing this collection together, Professor Ward has not only visited various portions of this country and Europe, Asia and Africa, but has correspondents all over the world, and is constantly receiving from them most varied and rare material. While we were there he had just finished the preparation of a giraffe, thirteen feet in height, and was unpacking boxes containing a moose from Nova Scotia, a caribou from Maine, a bear from Pennsylvania, a huge basking-shark from the Atlantic coast; and, from Professor Agassiz, a walrus, a small whale, and the rare Rocky Mountain goat, to be mounted for the Cambridge museum.

One building is devoted to taxidermy. The upper room in this building is a wonder to behold; hanging from the ceiling are hundreds of skins, including Apes, Monkeys, Wolves, Bears, Hyænas, Lions, Tigers, Sloths, Ant-eaters, Armadillos, Buffaloes, Deer, Elk, Moose, Giraffe, Yak, Wild Boar, Peccaries; besides an immense collection of such animals as Kangaroos, Echidna, Wombat, Tasmanian devil, Ornithorynchus, Thylacinus, and other rare skins. Some huge Alligators, Turtles, Iguanas and other reptiles completed the display. In an adjoining room are kept fishes, batrachians, and other specimens in alchohol; among these are Lepidosteus, Amia, Menopoma, Spatularia, Scaphiorynchus, Aspidonectes, and other American species of anatomical interest. Still another building is devoted exclusively to the preparation of skeletons; these are received with the flesh dried upon them, and are subjected to a long process of maceration and bleaching; over fifty vats are ready to receive them. These vats are all systematically numbered, and the most painstaking care is manifested to secure every bone so that each specimen may be perfect. Custom work is combined with all this; and hundreds of specimens are received from the museums of Cambridge, Boston, Salem, Philadelphia, Albany, and many of our colleges, for the purpose of being properly prepared and mounted.

We have dealt thus in detail that the public may know the true character of the enterprise in which Professor Ward is engaged; and the duty of every one interested in science and education to cordially sustain him.

Professor Ward has by long study and by travel in foreign countries, as well as by his long experience as a professional teacher of zoology and geology, fitted himself for the important and arduous task before him.

He has received the unqualified endorsement of the leading naturalists, and his untiring devotion to the work, and the immense outlays he has made, should be widely known among those who desire to sustain in this country an institution where one may secure the material for the foundation of a museum, as well as examples for educational purposes.—E. S. Morse.—*Am. Nat.*

[We have received from Prof. Ward a catalogue of the osteo logical specimens in his cabinet at Rochester. It is evidently prepared with much care, and, as each specimen has the price opposite it, will be very valuable to those wishing to procure osteological specimens for museums or private cabinets.—Ed. *Can. Nat.*]

OBITUARY.

Gustav Rose.—This distinguished mineralogist and chemist died at Berlin, July 15, in the 76th year of his age. In him Germany and the world have lost a wise and noble man,—conceded by all to be the first in his science among the learned men of Germany. He was the younger brother of Heinrich Rose, the chemist, and the youngest of four sons of Valentin Rose, who was Assessor in the "Ober-Collegium Medicum" of Berlin; and grandson of Valentin Rose the elder, discoverer of the "Rose'-schen" metals. He early lost his father, and his excellent mother looked after the culture of four sons, whose youth fell upon hard and trying times. All four brothers served their country in the war for freedom. Gustav, born on the 18th of March, 1798, and 17 years old at the date of the battle of Waterloo, did not go into that battle, but made the march under arms from Berlin to Orleans.

At first devoting himself to engineering, he fell sick of lung-fever. During his convalesence he gave himself to scientific pursuits, and this, as well as the influence of his brother Heinrich, led him to leave engineering and devote himself entirely to science. He went to Stockholm where Heinrich was already working under the immortal Berzelius. In 1823 he took up his residence in Berlin. In 1826, he became "Extraordinary," and in 1839, "Ordinary" Professor of Mineralogy in the University of Berlin, and, after the death of Weiss, Director of the Royal Mineralogical Museum.

It was the privilege of Gustav Rose to travel extensively, in Scandinavia, England and Scotland, Italy and Sicily, France and Austria. In the year 1829, he made, with Humboldt and Ehrenberg, the famous tour to the Ural and Altai Mountains and the Caspian Sea, and beyond to the borders of China, a journey which first made known the mineralogical resources of the extensive Russian Empire. His researches on his native soil were confined to the Silesian Mountains.

G. Rose was the first in Germany to use the reflecting goniometer in accurate measurements of the angles of crystals. He took an active part in the researches which led Mitscherlich to the important discovery of isomorphism. His work covered all departments of mineralogy, the form and combinations of crystals, physics in its applications to crystallized substances, the chemical constitution of minerals, and their artificial formation. He was the great master in the art of crystallographic drawing. The science of the association of minerals in rocks, petrography, originated with him. He was also the first to teach us the method of studying rocks by means of thin microscopic sections mounted on glass slides, in which minerals invisible to the unaided eye are disclosed.

With a special predilection he devoted himself to the study of meteorites, those wonderful bodies which reach the earth from the depths of space. With his keen penetration he discovered the structure of the iron meteorites and the mineral components of stony meteorites, and studied out the striking differences between rock-making in a cosmic atom, and in the solid crust of the earth.

It is worthy of remark that his best mineralogical discoveries were made not always on rare bodies, but often on those which had been long familiar and were common in collections. An example of this is his recognition of right and left-handed quartz crystals by their exterior forms; the complex twin crystals of the same species, etc. The secret of his success was that he did not observe simply form, but all the physical characters of the species; when searching into nature's work, his mind grasped whatever in the wide range of facts could serve as a key to the solution of the difficult problem before him. During his later years his researches were devoted to the "king of stones," the diamond. Few mineralogists would have thought that the diamond yet offered unsolved problems. In his anxiety that his work should not be lost to science, only twenty-four hours before his death he dictated to his son the results of his latest researches. Perhaps the final solution of the problem of the crystallization of the diamond was not attained by him; but he was near reaching his aim. His life, in thought and action, reflected Bacon's maxim "Pertransibunt multi, sed augebitur scientia." He was a true student of nature, an eminent and effective worker for the progress of science and the exposition of the system of nature.

We can scarcely find a better example than in Gustav Rose of the joy from a growing knowledge of nature lasting to the evening of life. Looking back over his long life, he saw how many dark paths of science had been followed out and made clear. This filled him with delight and high hope. "You will yet have more light," he said to the young. "Much must perish, but science will continue to increase." He saw his co-workers and best friends, Mitscherlich, Magnus, Haidinger, above all, his brother Heinrich, called from their work. Their departure and his increasing loneliness filled him with pain. Still he rejoiced in the thought of how much science had been advanced by the common efforts of his departed friends. Thus his spirit exhibited the uncommon spectacle of augmenting cheerfulness to life's close. Three years since it was decided to celebrate his "Doktor-Jubiläum," on the occasion of his completing a half century as an instructor. He never sought honors, but nevertheless all honors fell to his share. When he was made Knight of the Order *pour la mérite*, he considered the distinction too great for him.

Imperishable is the memory which Gustav Rose has left. Not only imperishable, but a memory that is living and active in the hearts of all who knew him. In his science and his many-sided relations to life, he had no enemy, no opponent, no envy, no evil-wisher to disturb him. He lived in a profound peace, of which his eyes were the speaking witness, whose peculiar soulfull outlook astonished all with whom he spoke. What is often so hard to the best men, to live in peace and friendship, was allowed to him. As he always strove to judge from a sense of the good, the true and the beautiful, so he expected the same judgment from others. He recognized in the efforts of others only the good. If words and deeds did not accord with his views, he did not attribute to others evil motives—and thus he won to himself the love and respect of all who came in contact with him.

Gustav Rose, in his life, as well as in his science, has left us an example hard to imitate. Until the 11th of July he still gave his lectures. Notwithstanding his great debility,—feeling, he says, "as if I had climbed the "Hummerich" and the "Löwenburg,"—he wrote in the evening a long scientific letter, closing with the words "Rest will do us good; we will go again to our old quarters in Friedrichshafen; would we were there now!" Scarcely had he closed the letter when he was seized with a chill, the premonitory symptom of pneumonia, which, in less then four days ended the life of the best of men.

Now rests from its work the hand which wielded the hammer with strength, and with exquisite delicacy drew the finest lines of crystal figures; and from their work rest the eyes which saw the snowy summits of the Altai, and distinguished the "matt" and the "glänzend" on the surfaces of rock-crystals. Peace to his ashes! Blessed are the peacemakers!—*Am. Jour. Science.* *

ATHENÆUM SCRAPS.

A large mass of meteoric iron has been discovered, by Herr B. Schreibter, at Neuntmannsdorf, in Saxony. The iron contains 5·31 per cent. of nickel. This interesting specimen has been acquired by the Royal Mineralogical Museum in Dresden.

The conditions necessary for the formation of azurite, or blue carbonate of copper, have been carefully studied by Dr. Wibel, of Hamburg. His experiments show that azurite is formed from malachite, or the green carbonate, by abstraction of water, and addition of carbonic acid; a change which may be effected at ordinary temperatures, by the action of carbonic acid in the presence of a water-abstracting agent.

An improved method of gilding on iron and similar metals has been introduced by Herr W. Kirchmann. The surface of the metal, even when oxidized, may be prepared by treatment with sodium-amalgam; chloride of gold is then poured over the amalgamated surface, and, by application of heat, the mercury may be expelled, leaving an uniform film of gold capable of receiving a polish.

The supply of lithographic stone from Germany has been gradually falling off—hence it is important to notice the discovery of two sources of supply in Italy, one near the French frontier and the other on the coast of the Gulf of Genoa. It is said that the stones are of superior quality.

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* From the German of Prof. Vom Rath, of Bonn.

The *Bulletin de la Société Chimique de Paris*, amongst many chemical papers of much interest, draws some attention to a waterproof glue, which promises to be of considerable value. The action of light in rendering the size on paper, when it is coated with the bichromate of potassa, insoluble was first noticed by Mr. Mongo Ponton, and the principle has been applied to several of the photographic printing processes. Gum, glue or gelatine may thus be rendered insoluble, and the action takes place, though slowly, in the dark. A concentrated solution of the bichromate of potassa is kept in the dark, and some of it is added to boiled gelatine. Anything glued with this may, after a little time be washed with hot water without effect. A parchment paper, used for wrapping the pea-sausages of the German soldier, is prepared by M. J. Stinde with this chromatized gelatine.

During an unusually heavy snow-storm in Stockholm, which continued for five or six days in December, 1871, Nordenskjöld detected, even in those portions of the snow which fell latest, a black carbonaceous powder, charged with very small spangles of metallic iron. He has since found similar substances in the snows of the Arctic Regions and from the heart of Finland. It will be curious to learn from the analysis, which he has recently promised, whether the iron in this cosmical dust is similar to meteoric iron.

Attention has been called, by Prof. B. Silliman, to the probable occurrence of small diamonds in the sands left in the sluices of hydraulic washings in California. A microscopic examination of a sample of these sands, from Cherokee, in Butte County, revealed the existence of numerous crystals of hyacinth or zircon, associated with crystals of topaz, fragments of quartz, black grains of chromite and titanic iron-ore, and a few small masses of a highly refracting substance, which, from its physical and chemical characters, is believed to be true diamond. The occurrence of diamonds in California has long been known, although not under these circumstances.