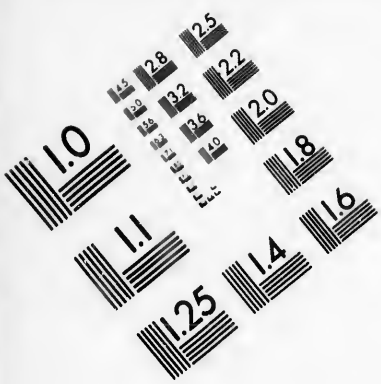

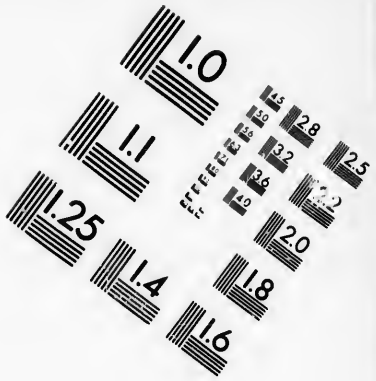

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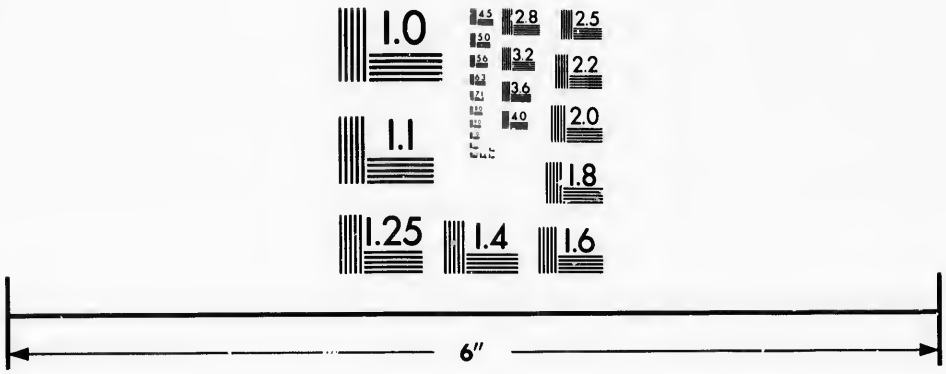

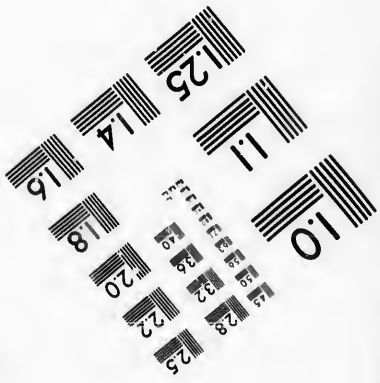

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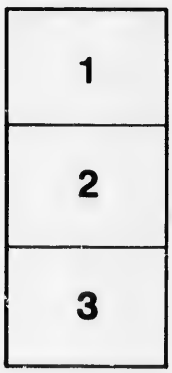

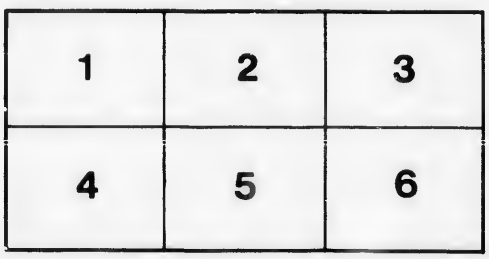

"*Reprinted from the Canadian Record of Science, July, 1896.*"

Pre-Cambrian Fossils Especially in Canada.

(Abstract of a paper by Sir W. Dawson, LL.D., F.R.S. Read in the Geological Section of the British Association, Liverpool Meeting, September, 1896.)

The paper was intended to be introductory to the exhibition by the lantern of specimens of *Eozoon Canadense*, for the purpose of showing its structures to geologists who may not have had opportunities of seeing authentic or perfect specimens. Canadian examples of the rocks and fossils were referred to, because that country possesses the greatest areas and the best exposures of Pre-Cambrian rocks, because in that country large portions of them have been well explored and mapped, and because, in Canada, Eozoon was first discovered.

The base of the Cambrian system may, for the present, be fixed at the lower limit of the Olenellus fauna, now recognized in Newfoundland and in the western part of Canada, as well as in the United States. With this the Protolenus horizon of Matthew in Southern New Brunswick should probably be associated; and there, as well as in Newfoundland, the lowest bed of the series is marked by a barren sandstone.[1] The Olenellus Zone affords, according to Walcott, 165 species, representing all the leading types of Marine Invertebrate life.[2]

Beneath this, in New Brunswick and Newfoundland, is a great thickness of red and greenish slates or shales, resting on a base of conglomerate, which lies unconformably on the Huronian system (Coldbrook Series), of whose debris it is, in part, composed. It contains, as far as known, no Trilobites, but has a few fossils referred to Ostrocods, Mollusks, Worms, Brachiopods, Cystideans, and Protozoa. Matthew has named this group in New Brunswick the Etcheminian system. He regards it as Pre-Cambrian, but still Palæozoic. It seems to correspond

1 Matthew, *Protolenus Fauna*, Trans. Acad. Science, N.Y., March, 1895.
2 Memoir on Lower Cambrian, U.S. Geol. Survey.

with the Signal Hill Series and Random Sound Series of Murray and Howley in Newfoundland, with the Kewenian or Kewenawan Series of Lake Superior, which, according to the observations of the Canadian Survey, covers great areas between Lake Superior and the Arctic Sea. It may be correlated with the Chuar and Grand Canyon formations of Walcott in Arizona. In the latter these occur with a few other fossils, including a fragment of a Trilobite, numerous specimens of large laminated forms, which may be regarded as connecting the *Cryptozoon* of the Cambrian, and the *Archæozoon* of the Upper Laurentian with Eozoon.[1]

If, with Matthew, we regard the Etcheminian beds and their equivalents as lowest Palæozoic, then the fossiliferous formations underlying these should be included under the term *Eozoic*, proposed by the author many years ago in connection with the description of Eozoon; and the term Algonkian, used by the United States Geological Survey, will include both Palæozoic and Eozoic formations.[2]

Next below the Etcheminian in New Brunswick, Newfoundland, Lake Superior and Lake Huron, and also, apparently, in Colorado, we have the great thickness of mostly coarse, clastic sediments, associated with contemporaneous volcanic outflows and ash-rocks, originally described by Logan and Murray as the *Huronian* system. These rocks are of a character not likely to yield many fossils. There are, however, slates, limestones, and iron ores associated with them, which have afforded laminated bodies comparable with Eozoon, burrows of worms, spicules of sponges and indeterminate fragments referable to Algae or to Zoophytes. In rocks of similar age in Brittany, Barrois and Cayeux announce the occurrence of Sponges, Foraminifera and Radiolarians.

[1] Hall, Report on Palæntology of N. York, No. 36, Matthew Bulletin, N. Brunswick, Nat. Hist. Society, 1890, Walcott l.c.

[2] This term is, in any case, unhappy in form and sense, and perhaps should be dropped.

Doubt has, however, been cast on these in a recent paper by Dr. Rauff, of Bonn. It is not improbable that the Huronian may admit of sub-division into two members; and, if its deep sea limestones could be found, perhaps into three. It underlies the Etcheminian unconformably, and, so far as known, is itself unconformable to the Laurentian, which must have been subjected to some disturbance and to much intrusion of igneous matter, as well as to great denudation, before and during the Huronian period.

Next in descending order is the Upper Laurentian, or *Grenvillian* system (the upper part of Logan's Lower Laurentian), which is well developed in the St. Lawrence and Ottawa Valley and also in New Brunswick, as well as in the Adirondacks and the eastern slope of the Apalachians. It contains various gneissose and schistoze rocks, which, though crystalline, show, on analysis, the same composition with Palæozoic slates,[1] and it includes also bands of quartzite and of graphite and graphitic schist, as well as large beds of magnetite. Above all, it is remarkable for the occurrence of great zones or belts of limestone, associated with what seem to be altered sedimentary beds, and is in many places rich in graphite and in apatite. It is scarcely possible to doubt that in this great system of several thousands of feet in thickness we have evidence of tranquil oceanic deposition and of abundant animal and vegetable life. It, no doubt, also occupies great areas covered by later deposits, while there is evidence that the portions exposed have undergone enormous denudation.

The graphite of this system has yielded no distinct structures, except imperfectly preserved fibres; but in some places it assumes the form of long ribbon-like bands, suggestive of fronds of algæ, and an American palæontologist, Mr. Britton, has described one of these forms from

[1] Adams—Am. Journal of Science, July, 1895.

the Laurentian limestone of New Jersey, under the name of *Archacophyton Newberrianum*.[1]

It is in one of the limestones, the highest of the series, rich in nodules and grains of Serpentine, that the forms described as *Eozoon Canadense* occur. It is not the object of this paper to enter into any details as to these, or any discussion of their claims to be regarded as of animal origin, but to allow the specimens exhibited to speak for themselves, referring to previous publications for a more particular account of their structure and modes of occurrence.[2]

Below the Grenville series we find an immense thickness of orthoclase gneiss, associated with igneous dykes and masses, without limestones or other indications of organic remains, but presenting alternations with thick bands of Hornblendic schist. This is the "Ottawa gneiss" of the Geological Survey of Canada, a fundamental rock, perhaps a portion of the primitive crust of the earth, or a product of aqueo-igneous, or crenitic action, before the beginning of regular sedimentation. It is the Lower Laurentian or Archæan complex of some authors, and is quite distinct from the overlying Grenvillian, except in the occurrence of orthoclase gneisses in both.

The Eozoic group of systems will thus for the present include the Huronian and Grenvillian or Upper Laurentian, the fauna of which is characterized by the prevalence in the former of Annelida, Sponges and Protozoa, and in the latter, so far as known, of Protozoa alone, represented by peculiar and gigantic forms, as Eozoon and Archæozoon, and some smaller types (Archæospherinæ).

As at present known, these systems are of a character unfavorable to the preservation of organic remains—the Huronian because of its coarse and littoral character, the Grenvillian because of its great metamorphism. It may,

1 Annals N.Y. Academy, Vol. IV., No. 4.

2 See papers in the Geological Magazine for 1895, also Memoir in Publications of Peter Redpath Museum.

however, be hoped that should deep sea deposits of Huronian age be discovered, or the Grenvillian rocks in a less altered state, additional species may be found; nor is it impossible that there may be additional formations filling the probable gaps in time between the Lower Laurentian and the Grenvillian, or between it and the Huronian, or between the latter and the Etcheminian. In any case there is ample scope for the labor of those who have the necessary skill and patience. It was added that important detailed explorations of the Laurentian and Huronian, supplementary to those of Logan, are now in progress, under Dr. Dawson, Director of the Geological Survey of Canada; more especially by Dr. Ells, Dr. Adams and Mr. Barlow, and may be expected to yield important results.

In concluding, the author insisted on the duty of palæontologists to give more attention to the Pre-Cambrian rocks, in the hope of discovering connecting links with the Cambrian, and of finding the oceanic members of the Huronian, and less metamorphosed equivalents of the Upper Laurentian, and so of reaching backward to the actual beginning of life on our planet, should this prove to be attainable. At the close of the paper a number of micro-photographs, showing the forms and structures of Eozoon and other ancient remains, supposed to be organic, were projected on the screen.

The President said that they were all delighted to have the subject presented in this way. The dawn of life on the globe was, perhaps, the most fascinating of all subjects with which the geologist had to deal. The subject of Eozoon Canadense was intimately associated with the name of Sir William Dawson.

Dr. Hicks said no one else could possibly have given such an exposition of Eozoon.

In the discussion which followed, Mr. Matthew, Dr. Johnston Lavis, Sir James Grant, Professor Rupert Jones, Professor Bonney, and others took part. One speaker remarked that Eozoon had been attacked for many years, but there were some geologists who still had faith in it.

In responding, Sir William Dawson thanked the speakers for the fair and friendly manner in which they had received his old friend of the Laurentian rocks, and hoped it was not merely on the principle that nothing but good was to be said of the dead. His object had been to exhibit to a representative audience a series of characteristic examples of these curious objects, leaving those present to form their own conclusions. In any case, he thought they must admit that the discussion of the subject had been of advantage to science; and he hoped it would eventually lead to a great extension of our knowledge of the earliest forms of life.

It was announced that additional specimens were on exhibition at University College Museum, and that some of these would be demonstrated under the microscope on the following afternoon. (Partly from Report in Liverpool *Post*.)