224

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NOTE ON NEW FACTS RELATING TO EOZOON CANADENSE.[1]

By SIR J. WILLIAM DAWSON, LL.D., F.R.S., etc., etc.

(PLATE IV.)

THE late Dr. Carpenter had undertaken an elaborate series of investigations of Eozoon, based on all the material collected by myself and others in Canada, with the view of preparing a complete and exhaustive memoir on the subject. In consequence of this arrangement the new facts obtained for several years have remained unpublished. Unhappily the work was left at his lamented decease in a very incomplete state.

The present note is intended, without entering into any controverted points, to notice some new facts respecting the fossil and its state of preservation, which have been disclosed within the few past years.

1. *Form of Eozoon Canadense.*

Hitherto this has been regarded as altogether indefinite, and it is true that the specimens are often in great confluent masses or sheets, the latter often distorted by the lateral pressure which the limestone has experienced. The specimen from Tudor, however, figured by Sir W. E. Logan in the 'Quarterly Journal of the Geological Society,' 1867, p. 253, and that described by me in the 'Proceedings of the American Association' in 1876, and figured in my work "Life's Dawn on Earth," gave the idea of a turbinate form more or less broad. More recently additional specimens weathered out of the limestone of Côte St. Pierre have been obtained by Mr. E. H. Hamilton, who collected for me at that place; and these, on comparison with several less perfect specimens in our collections, have established the fact that the normal shape of young and isolated specimens of *Eozoon Canadense* is a broadly-turbinate, funnel-shaped, or top-shaped form, sometimes with a depression on the upper surface giving it the appearance of the ordinary cup-shaped Mediterranean sponges. (See Pl. IV. Fig. 1.) The photographs exhibited show this appearance in two specimens. These specimens also show that there is no theca or outer coat either above or below, and that the laminæ pass outwards without change to the margin of the form, where, however, they tend to coalesce by subdividing and bending together. The laminæ are thickest at the base of the inverted cone, and become thinner and closer on ascending, and at the top they

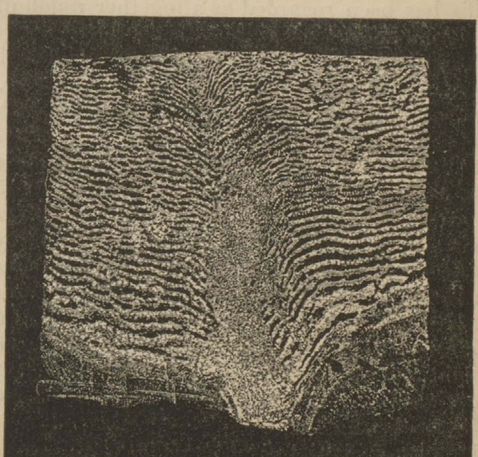
[1] Read at the Meeting of the British Association, Sept. 5, 1887.

become confounded in a general vesicular or acervuline layer. I feel now convinced that broken fragments of this upper surface scattered over the sea-bottom formed those layers of *Archæosphærinæ* which at one time I regarded as distinct organisms.

It is to be observed, however, that other forms of Eozoon occur. More especially there are rounded or dome-shaped masses, that seem to have grown on ridges or protuberances, now usually represented by nuclei of pyroxene.

2. *Pores or Oscula.*

In the large number of specimens of Eozoon which have been cut or sliced in various directions, and are now in our Museum at Montreal, it has become apparent that there are more or less cylindrical depressions or tubes, sometimes filled with serpentine and sometimes with inorganic calcite, crossing the laminæ at right angles. These seem to occur chiefly in the large and confluent masses, and are without any regular or definite arrangement. In some of the narrower openings of this kind the laminæ can be observed to subdivide and become confluent on the sides of these tubes, in the same manner as at the external surface. This circumstance induces me to believe that these are not accidental, but original parts of the structure, and intended to admit water into the lower parts of the masses. A characteristic example of a fortunately weathered specimen is seen in the photograph accompanying this paper. (See Pl. IV. Fig. 2.) A central canal of a similar kind is well shown in the accompanying illustration.



Section of the base of a turbinate or top-shaped *Eozoön*. This specimen shows an osculiform, cylindrical perforation, cut in such a manner as to show its *reticulated wall* and the descent of the laminæ toward it. Two-thirds of natural size. Coll. Carpenter.

[This illustration (from Prof. Prestwich's "Geology," vol. ii. p. 21) has been courteously lent by the Clarendon Press, Oxford.]

from the photograph.

3. *Beds of Fragmental Eozoon.*

If Eozoon was an organism growing on the sea-bottom, it would be inevitable that it would be liable to be broken up, and in this condition to constitute a calcareous sand or gravel. I have already in previous papers described Laurentian limestones containing such fragments from the Grenville band at Côte St. Pierre, from the Adirondack Mountains in New York State, from Chelmsford, Massachusetts, and from St. John, New Brunswick, as well as from Brazil, and the Swiss Alps. Indeed, the Laurentian limestones of most parts of the world hold fragmental Eozoon. In the Peter-Redpath Museum are some large slabs of Laurentian limestone sawn under the direction of Sir W. E. Logan, and showing irregular layers and detached masses of Eozoon with layers or bands of limestone and of ophiolite. These are evidently layers successively deposited, though somewhat disturbed by subsequent movements. On selecting specimens from the white and more purely calcareous layers, I was pleased to find that they abound in fragments of laminæ of Eozoon, having the canals filled either with dolomite or with colourless serpentine. Other portions of the limestone show the peculiar granulated structure characteristic of the calcareous laminæ of Eozoon, but without any appearance of canals, which may in this case be occupied with calcite, not distinguishable from the substance of the laminæ. There are also indications in these beds of limestone of the presence of Eozoon not infiltrated with serpentine, but having its laminæ either compressed together, or with the spaces between them filled with calcite. There are other fragments which, from their minute structure, I believe to be organic, but which are apparently different from Eozoon.

4. *Veins of Chrysotile.*

I have in previous papers abundantly shown that the veins of fibrous chrysotile which abound in serpentinous limestones of the Laurentian are of secondary aqueous origin, as they fill cracks or fissures not merely crossing the beds of the limestone, but passing through the masses of Eozoon and the serpentinous concretions which occur in the beds. They must, therefore, have been formed by aqueous action long after the deposition, and in some cases after the folding and crumpling of the beds. In this respect they differ entirely from the laminæ of Eozoon, which have been subject to the same compression and folding with the beds themselves.

The chrysotile veins have, of course, no connection with the structures of Eozoon, though they have often been mistaken for its more finely tubulated portion. With respect to this latter, I believe that some wrong impressions have been created by defining it too rigorously as a "proper wall." In so far as I can ascertain, it consisted of finely divided tubes similar to those of the canal-system, and composed of its finer subdivisions placed close together, so as to become approximately parallel, as in the photograph No. 4, sent herewith.

5. *Nodules of Serpentine.*

Reference has been made in previous papers to the nodules and grains of serpentine found in the Eozoon-limestone, but destitute of any structure. These nodules, as exhibited in the large slabs already referred to, have however often patches of Eozoon attached to, or imbedded in them, and they appear to indicate a superabundance of this siliceous material accumulating by concretionary action around or attached to any foreign body, just as occurs with the flints in chalk. The layers of grains and serpentine parallel to the bedding appear to be of similar origin.

6. *State of Preservation.*

Recent observations more and more indicate the importance and frequency of dolomite as a filling of the canals, and also the fact that the serpentine deposited in and around the specimens of Eozoon is of various qualities. Dr. Sterry Hunt has shown that the purely aqueous serpentine found in the Laurentian limestones is of different composition from that occurring with igneous rocks, or as a product of the hydration of olivine. There are, however, different varieties even of this aqueous serpentine, ranging in colour from deep green to white; and one of the lighter varieties has the property of weathering to a rusty colour, owing to the oxidation of its iron. These different varieties of serpentine will, it is hoped, soon be analysed, so as to ascertain their precise composition. The mineral pyroxene, of the white or colourless variety, is a frequent associate of Eozoon, occurring often in the lower layers and filling some of the canals. Sometimes also the calcareous laminæ themselves are partially replaced by a flocculent serpentine, or by pyroxenic grains imbedded in calcite.

7. *Other Laurentian Organisms.*

In a collection recently acquired by the Peter-Redpath Museum, from the Laurentian of the Ottawa district, are some remarkable cylindrical or elongated conical bodies, from one to two inches in diameter, which seem to have occurred in connection with beds or nodules of apatite. They are composed of an outer thick cylinder of granular dark-coloured pyroxene, with a core or nucleus of white felspar; and they show no structure, except that the outer cylinder is sometimes marked with radiating rusty bands, indicating the decay of radiating plates of pyrite. They may possibly have been organisms of the nature of *Archæocyathus*; but such reference must be merely conjectural.

8. *Cryptozoum.*

The discovery by Prof. Hall, in the Potsdam formation of New York, and by Prof. Winchell in that of Minnesota, of the large laminated forms which have been described under the above name, has some interest in connection with Eozoon. I have found fragments of these bodies in conglomerates of the Quebec group, associated with Middle Cambrian fossils; and, whatever their zoological relations, it is evident that they occur in the Cambrian rocks under the same conditions as Eozoon in the Laurentian. I find also in the Laurentian limestones certain laminated forms usually referred to Eozoon, but which have thin continuous laminæ, with spongy porous matter intervening, in the manner of *Cryptozoum* or of *Loftusia.* Whether these are merely Eozoon in a peculiar state of preservation or a distinct structure I cannot at present determine.

9. *Continuity and Character of containing Deposits.*

At a time when so many extravagant statements are made respecting the older crystalline rocks, it may be proper to state that all my recent investigations of the Middle Laurentian vindicate the results of the late Sir William Logan as to the continuity of the great limestones, their regular interstratification with the gneisses, quartzose gneisses, quartzites, and micaceous schists, and their association with bedded deposits of magnetite and graphite, and also the regularity and distinctly stratified character of all these rocks. Farther, I regard the Upper Laurentian, independently of the great masses of Labradorite rocks, which may be intrusive, as an important aqueous formation, characterised by peculiar rocks, more especially the anorthite gneisses. I am also of opinion that the so-called crystalline Huronian rocks of the country west of Lake Superior are stratigraphically, and to a great extent lithologically, equivalent to the Upper Laurentian of St. Jerome and other places in the Province of Quebec, differing chiefly in the greater or less abundance of intrusive igneous rocks.

10. *Imitative Forms.*

The extraordinary mistakes made by some lithologists in studying imperfect examples of Eozoon and rocks supposed to resemble it, and which have gained a large amount of currency, have rendered necessary the collection and study of a variety of laminated rocks, and considerable collections of these have been made for the Peter-Redpath Museum. They include banded varieties of dolerite and diorite, of gneiss, of apatite and of tourmaline with quartz, laminated limestone with serpentine, graphic granites, and a variety of other laminated and banded materials, which only require comparison with the genuine specimens to show their distinctness, but many of which have nevertheless been collected as specimens of Eozoon. I do not propose to enter into any detailed description of these here, but hope, with the aid of Dr. Harrington, to notice them in forthcoming Memoirs of the Peter-Redpath Museum.

POSTSCRIPT.—It has been suggested by Mr. Julien[1] and others that Eozoönal structure may be due to the alternation of mineral layers formed in the passage-beds between concretions and their enclosing mass. The objections to this view are :

1. Laminated passage-rocks and laminated concretionary forms

[1] Proceed. Amer. Assoc. vol. xxxiii. 1884, pp. 415, 416.

have only simple laminæ, whereas *Eozoon* has connected or reticulatory laminæ.

2. Laminated passage-rocks have no structure other than crystalline. *Eozoon* has beautiful tubulation in its calcareous walls, besides large tubes or oscula.

3. Sometimes (not usually) pyroxene is the siliceous part of *Eozoon*; or, as we hold, the mineralizing agent. More usually it is serpentine, sometimes loganite, or dolomite, or mere earthy limestone. It is not possible that all these minerals should assume the same forms.

4. Pyroxene and serpentine both occur in nodules and bands in the Laurentian limestones, and in most cases without any traces of *Eozoon*, while *Eozoon* occurs in the limestone remote from such nodules and bands, where no passage of any kind can occur, and presents distinct forms.

5. There are only two localities known to me, one in a quarry near Côte St. Pierre, and one at Burgess, where a bed with badly-preserved *Eozoon* occurs in a manner which would not even suggest an idea. Pyroxene is present in the one case, and loganite in the other.

6. I have often thought of this suggested explanation, and have compared *Eozoon* with all sorts of banded and passage-rocks taken from the Laurentian and other formations, but have seen no reason to adopt such a view for *Eozoon*. ~~I may add that~~ in the Peter-Redpath Museum at Montreal I have accumulated a very large number of laminated and passage-rocks and concretions for purposes of comparison.

7. How on such an hypothesis can we explain the beds of limestone composed of or filled with fragments of *Eozoon*?

EXPLANATION OF PLATE IV.

Fig. 1.—Small specimen of *Eozoön*, separated from the matrix, and showing a turbinate form. Nat. size. Coll. Dawson.

Fig. 2.—Weathered specimen of *Eozoön*, showing a section through the middle, with two cylindrical, osculiform, vertical tubes. The modification of the laminæ at the sides of the tubes is similar to that at the exterior. Nat. size. Coll. Dawson.

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