

ART. XXVIII.—*Principal J. W. Dawson's criticism of my Memoir On the Structure of Eozoon Canadense compared with that of Foraminifera*; by K. MÖBIUS, Professor of Zoology at Kiel.*

IF it were true that "the organic character of Eozoon is at present generally admitted," as Dr. Dawson says in his criticism on my memoir, I could have spared myself the trouble of elaborating, and others that of reading, my studies. But every one who has paid attention to this question knows that this statement of Dr. Dawson is not correct. As long as two different opinions about one object in nature are maintained, and on both sides by men whose learning and honesty in the search for the truth cannot be questioned, so long are renewed studies and descriptions of the differently judged object a scientific duty for all who believe that they have the true explanation. For every phenomenon in nature but one thoroughly true explanation is possible. This principle, as stated in my memoir (p. 178), has guided me in preparing it for the scientific public.

Dr. Dawson says further, "As fast as one opponent" (against the organic character of Eozoon) "is disposed of, another appears." And he rises, himself, to dispose of me, the last of the opponents.

* For Dr. Dawson's paper see this Journal, xvii, 196, March, 1879.

[Thinking that Professor Möbius should have, if he desired, an opportunity to reply to Dr. Dawson's criticism, and that science would profit thereby, we offered him the pages of this Journal, and stated that we should be pleased if he would occupy them and give his views on the subject; informing him, at the same time (in order to remove any objections that might arise in his mind), that there would be no rejoinder in this Journal. Professor Möbius has accordingly prepared for us the article now published. J. D. D.]

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No one should be able to do so better than he. It was he who described the *Eozoon Canadense* as an organism; who has, moreover, a very fine collection of specimens of Eozoon, and has studied the Eozoon *in situ* and is fully acquainted with the literature relating to it. I could not, indeed, have wished for a more experienced reviewer, to show me where I had fallen into error and where I had found the truth.

It is Mr. Dawson's belief that few scientific men are in a position fully to appreciate the evidence respecting the organic character of Eozoon; that this is true of the geologists and mineralogists, because they do not yet agree with regard to the nature of the rocks in which it occurs; and of the biologists, because "they are but little acquainted with the appearance of foraminiferal organisms when mineralized with silicates." "Nor are they willing," he says, "to admit the possibility that these ancient organisms may have presented a much more generalized and less definite structure than their modern successors. Worse, perhaps, than all these, is the circumstance that dealers and injudicious amateurs have intervened and have circulated specimens of Eozoon, in which the structure is too imperfectly preserved to admit of its recognition." These are the principal points in the introduction to Principal Dawson's criticism on my paper. He continues: "The memoir of Professor Möbius affords illustrations of some of these difficulties in the study of Eozoon."

I hope Principal Dawson will concede that, in my memoir, there is no evidence that the different hypotheses with regard to the geological character of the strata in which the Eozoon occurs have puzzled me; nor that any previously conceived hypothesis has influenced me in my conclusions. To hypotheses of this kind I have briefly alluded in the last chapter of my memoir where I say: "While excluding Eozoon from the organic world by scientific arguments, it is by no means maintained that in the Laurentian period there may not have existed organisms. It is possible that the graphite of the Laurentian beds may have originated from organisms." These words ought plainly to have shown Mr. Dawson that no geological hypothesis compelled me in advance to deny the organic nature of Eozoon. On the contrary, in the beginning of my studies I hoped to gain conclusive evidence in favor of the organic character of Eozoon, as I have stated in my memoir, chapter VI: "It is to me a source of regret that I cannot say to Messrs. Dawson and Carpenter, who have so kindly aided me in my work, that *Eozoon Canadense* must be considered, from my researches also, a fossil Foraminifer." I quote these words here for the benefit of those readers of Principal Dawson's criticism who are not acquainted with my memoir.

I was familiar with the structure of fossilized Foraminifera, as can be seen from several notations and figures in my paper. Nor was I unwilling to admit that the structure of Eozoon might be different from that of modern Foraminifera, as is evident from the following words in my memoir (p. 188):

"If all the structures of Eozoon, in the same layers and forms that they have in the best specimens circulated by Dawson and Carpenter, were indeed produced by living beings, the living Eozoon must have had a nature totally different from that of all plants and animals we know. If it were possible to prove that Eozoon is a fossil and not a mineral, we must then make two divisions of organic bodies, viz: 1, organic bodies with protoplasmic nature (all plants and animals); 2, organic bodies with eozoonic nature (*Eozoon* Dawson). In the genealogical line, in which the theory of evolution or descent unites all protoplasmic beings, there is no place for Eozoon."

Further, not a single one of all the specimens of Eozoon, which I studied, came from the hands of "dealers or injudicious amateurs," but all directly or indirectly from Messrs. Dawson and Carpenter. This I have said repeatedly in my paper. I am consequently much surprised at the words of Dr. Dawson: "The memoir of Professor Möbius affords illustrations of some of these difficulties in the study of Eozoon."

Why should Principal Dawson write thus about my memoir if he has read it throughout with attention and understanding? It bears full evidence that I had not to struggle in the slightest degree with such difficulties.

But Principal Dawson has read my paper, and he points out *two errors* in it, viz: 1, I have (on p. 180) taken as a figure of full natural size a very large specimen of Eozoon, which Principal Dawson on plate III of his "Dawn of Life" has presented of half the natural size; 2, on the same page I say: "We know specimens of Eozoon which have more than fifty whitish and greenish laminæ," on which Mr. Dawson remarks, that they often have more than a hundred.

For these corrections I offer my sincerest thanks. Other substantial errors he has not mentioned. If he will do so, I shall be further grateful to him. For if in a paper of mine an error is unveiled, the first displeasure I feel in having not been careful enough to avoid making a mistake, is very soon effaced by the satisfaction of seeing the pure and certain truth come forth. No naturalist, in any branch of science, has ever discovered and brought out at once the whole truth in all directions. It is evident that those two mistakes are of no significance in deciding the question whether *Eozoon Canadense* is an organism or not.

But Dr. Dawson writes further (p. 197): "Möbius has

had access merely to a limited number of specimens mineralized with serpentine. These he has elaborately studied, and has made careful drawings of portions of their structures, and has described these with some degree of accuracy; and his memoir has been profusely illustrated with figures on a large scale. This, and the fact of the memoir appearing where it does, convey the impression of an exhaustive study of the subject, and since the conclusion is adverse to the organic character of Eozoon, this paper may be expected, in the opinion of many not fully acquainted with the evidence, to be regarded as a final decision against its animal nature. Yet, however commendable the researches of Möbius may be, when viewed on the evidence of the material he may have at command, they furnish only another illustration of partial and imperfect investigation, quite unreliable as a verdict on the questions in hand."

On reading these lines one cannot but be astonished and ask, whether they were written by the same author, who said a few lines before: "Professor Möbius is a good microscopist, fairly acquainted with the modern Foraminifera, and a conscientious observer." This impression he must also have gained from my paper on *Eozoon Canadense*.

Principal Dawson, in saying I have had access "*merely to a limited number of specimens*" of Eozoon, should have stated exactly how many specimens are to be studied to gain a conclusive judgment in regard to its real nature. It has often happened that biologists and paleontologists have had not more than one specimen in hand, or even not more than a part of a specimen, and notwithstanding they were in a position to determine surely its place in the organic kingdom. He says, further: "Möbius has made drawings of *portions* of the structure of Eozoon;" he does not state what structures I have omitted. I have certainly made careful drawings and descriptions of all the Eozoon-structure, which according to Messrs. Dawson and Carpenter corresponds with the chambers, the communications between them, the tubuli of the proper wall of the chambers, and the canal-system in the intermediate skeleton of Foraminifera.

Principal Dawson says again: "Möbius has described these structures with *some degree* of accuracy." It would have been more satisfactory if he had pointed out the imperfections of my descriptions, each one for itself and all without reserve. I should have been grateful for the aid in improving my descriptions of Eozoon.

Principal Dawson evidently apprehends that my "profusely illustrated" paper may convey the impression of an exhaustive study of the subject. That was indeed my purpose. Has he not read or understood my remarks (pp. 178 and 179) in regard to the necessity of many good drawings of all the structures of

Eozoon? Or, had he in writing his criticism the opinion that it would be read by those only who would never see my paper itself?

But how can he venture to say: "The fact of the memoir appearing where it does conveys the impression of an exhausting study of the subject?" A bad paper has never gained the continued assent of the public through the fame of the Journal in which it appeared. In giving my paper to the editors of the illustrious "*Palæontographica*" I had by no means the intention of gaining for it any higher opinion than it deserves by itself. I wished to bring it before a disinterested and judicious public; besides, I knew that the publisher of the "*Palæontographica*" would take care to print my drawings very exactly, and he has done so.

After having made these objections in general, Principal Dawson considers "a number of errors and omissions arising from want of study of the fossil *in situ*, and from want of acquaintance with its various states of preservation."

If Principal Dawson demands that nobody should venture to judge of the nature of Eozoon but those who have seen it *in situ*, he claims in favor of his *Eozoon Canadense* an exception over all productions of the accessible world. When writing these lines he overlooked the fact that Mineralogy, Paleontology, Botany and Zoology contain a very great number of universally appreciated memoirs concerning objects which the authors have never seen *in situ*.

It was my intention to study Eozoon from a biological point of view, which is indeed shown in the title of my memoir, viz: "*The structure of Eozoon Canadense, compared with that of Foraminifera, by my own investigations.*"

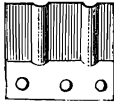
It seems strange that Principal Dawson quotes in his criticism but the first five words of this title. If it were actually so short, many things might have been left out which the real title promises. For my purpose, the examination of Eozoon from a *biological point of view*, I was in a very favorable situation, because a very large number of specimens of *Eozoon Canadense* were at my disposal, which Messrs. Dawson and Carpenter had sent directly to me or to other naturalists.

Can I now be reproached, that I accepted all specimens of Eozoon as genuine, which the two principal defendants of its animal nature had proved! But if Principal Dawson means that my drawings and descriptions were insufficient to show all variations and all degrees of preservation of his *Eozoon Canadense*, I would request him urgently to send me such specimens as will enable me to improve my researches. I shall accept them with my best thanks, study them very exactly, and will bring all I shall find conscientiously before the scientific public.

On p. 187 of my paper I say: "It is impossible to detect in any specimen of Eozoon any spot, from which there could have originated all the serpentine bodies of this specimen, and which therefore might agree with the primary chamber of Foraminifera." When Mr. Dawson, in alluding to these lines, writes (p. 198): "Möbius objects to the impossibility of detecting *regular* primary chambers like those in modern Foraminifera," he has interpolated the word, "*regular*," for the sake of the argument; he adds: "Möbius seems not to be aware that some Stromatoporeæ originate in a vesicular irregular mass of cells, and that in Loftusia the primary chamber is represented by a merely cancellated nucleus." From this it is evident, that *not I*, but *Mr. Dawson* has failed here.

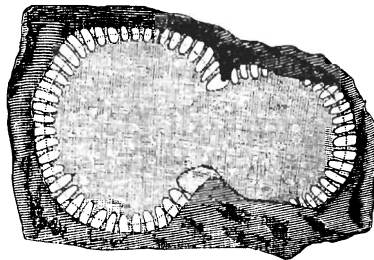
He says further: "With reference to the finely tubulated proper wall of Eozoon, Möbius has fallen into an error scarcely excusable in an observer of his experience, except on the plea of insufficient access to specimens." In writing this, Principal Dawson omitted to state that I studied only those specimens of Eozoon which had come from him and Dr. Carpenter, and that these were indeed very many in number. I beg him to read again the explanations of my drawings, and he will find in

1.



Cell-wall of Eozoon, when highly magnified; after J. W. Dawson.

2.



Tubuli in the Kempten mineral ($\times 220$).

many places quoted: "Nummuline tubulation," written from labels by Dr. Carpenter himself on the figured preparations. But Dawson agrees exactly in regard to the "Nummuline tubulation." Both Eozoonists consider the chrysotile veins as the proper wall filled with fine cylinders of silicate. I could not detect in any specimen of Eozoon the slightest traces of such tubuli as Principal Dawson has figured in "The Dawn of Life" (p. 106). I give here a copy of this figure (1). If Eozoon did indeed contain tubuli of such organic regularity, we should have reason enough to agree with him in considering it Foraminiferal, as well as the specimen from Kempten, Bavaria, which Principal Dawson advises me to study (p. 199). I can assure him that I did so before I wrote my memoir, and from prepa-

rations which were kindly forwarded to me by Dr. Hahn at Reutlingen. I add here a drawing of the tubuli in a slice (fig. 2).

Principal Dawson remarks: "That some of Möbius's specimens have contained the proper wall fairly preserved is obvious from his own figures, in which it is possible to recognize both this structure and the chrysotile veins, though confounded by him under the same designation." Why does he not state *what* figures these are, and why has he neglected to give a copy of them in his review, since he has taken some other figures of mine as evidence of the foraminiferal character of Eozoon?

In the same paragraph Principal Dawson speaks in detail of the different difficulties met with in distinguishing the minute tubes. I quote his own words, viz: "When the proper wall is merely calcareous, its structure is *ordinarily invisible*, and it is the same when the calcareous skeleton has, from any cause, lost its transparency, or has been replaced by some other mineral substance. Even in thickish slices, the tubes, though filled with serpentine, may be so piled on one another *as to be indistinct*." Indeed these lines are quite like an esoteric Eozoon mystery; but every true natural doctrine only contains exoteric theses.

Principal Dawson speaks of my description of what he calls the "Canal system." He urges that I was mistaken in thinking that round and regularly branching stalk-like bodies are rather exceptional. I can assure him that I have found in all specimens of Eozoon circulated by Dawson and Carpenter almost only such flat and irregular branched stalk-like bodies as I have illustrated in my figures. It ought to be admitted that as soon as the first objections against the organic character of Eozoon were made, Messrs. Dawson and Carpenter distributed *only good specimens* of Eozoon; and it would be very strange, if just those of their specimens which came into *my* hands had not the genuine structure, but such qualities as speak against the organic nature of Eozoon.

Principal Dawson brings before the readers of his criticism in the figures 1 and 2 (p. 201), two of my drawings of the stalk-like bodies traversing the associated limestone and regarded by Eozoonists as casts of canals. He has chosen just those which differ very little from figures which he and Carpenter have added formerly to their descriptions of Eozoon. Why did he not copy instead of these figures, drawings of the many isolated stalk-like bodies which fill up the "canal systems" and to which I devoted a whole plate? And why does he not speak of those of my drawings which present the casts of the "canal systems" colored by Fuchsin, showing beyond doubt that these are only irregularly curved stalks or plates.

I feel sure that Mr. Dawson will also get the same views of the real forms of the "canal system" if he will only employ

my methods. The two figures which he has chosen out of my plates can only serve as evidence for the foraminiferal nature of Eozoon to those readers of Mr. Dawson's criticism, who have never had my memoir in their hands. In selecting these two figures, Mr. Dawson has plainly proved that his views as to the canal nature of the stalk-like bodies are very weakly supported.

"Another objection against the organic nature of Eozoon," says Principal Dawson, p. 200, "Möbius takes to the directions of the canals, as not being transverse to the laminae, but oblique." Here Mr. Dawson did not understand me rightly. I say, chapter IV, p. 184, in regard to the fine tubes of Foraminifera (which are regarded as resembling the chrysotile fibers), that they are usually directed transversely to the inner and outer sides of the chamber-wall, and I show this by figures of Foraminifera, for instance, by the figure of a slice of a Nummuline, which Dawson has copied, fig. 4, p. 201. My remark about the direction of the fine tubes Mr. Dawson refers to his "canal system," to which it does not belong at all. It is therefore not *I*, but *Mr. Dawson*, who makes a mistake.

Paragraph 4 of Principal Dawson's criticism (p. 200), begins with the words: "A fatal defect in the mode of treatment pursued by Möbius is that he regards each of the structures separately and does not sufficiently consider their cumulative force when taken together." Principal Dawson has either not read, or not understood, chapter VI of my memoir. In this chapter my only object was to compare the structures of Eozoon, as a whole, with the structures of Foraminifera. I am convinced that I could not better explain the structure of Eozoon than by describing first each structure particularly, before I compared them all together with the Foraminifera; and all disinterested biologists and paleontologists will agree that there is no better method of treating such an object.

Next follows, in Dr. Dawson's criticism, a *resumé* of his well-known opinions about the organic nature of Eozoon. I will only make a remark about one of the eight points which he makes. He says, point 3: "The general form, lamination and chambers of Eozoon resemble those of the Silurian *Stromatopora* and its allies, and of such modern sessile Foraminifera as *Carpenteria* and *Polytrema*." No one who is minutely acquainted with the structure of Eozoon, *Stromatopora*, *Carpenteria* and *Polytrema* can maintain such an opinion. If Principal Dawson had only compared my figures of *Carpenteria*, *Rhaphidodendron*, and *Polytrema miniaceum*, closely with the structures of Eozoon, he would certainly not have made this statement.

The dear old *Polytrema*! Ever since the celebrated Professor Max Schultze said that it resembled Eozoon, *Polytrema* has served ever and anon as evidence for the organic nature of

Eozoon. If Max Schultze had been acquainted with the structure of Eozoon as well as with the structure of *Polytrema* his histological genius would certainly have prevented him from making such an assertion.

Further on, Mr. Dawson reproaches me for saying that: "Dr. Carpenter and Principal Dawson have leaned to a subjective treatment of Eozoon, representing its structure in a somewhat idealized manner." Where did I say this? On p. 188 I said about their diagrams of Eozoon: "Carpenter and Dawson show clearly by the diagrams of *Eozoon Canadense* that they assume for the supposed living being, which has, in their opinions, formed the shell of Eozoon, the power of producing structures of organic regularity." And, further, I say: "The individual peculiarities of diagrams should not exceed the limits of the known variability of the real specimens. But in the Eozoon diagrams of Carpenter and Dawson these limits are exceeded." These are my words. I am convinced that every naturalist who is free from prejudice will agree with me in regard to Carpenter's and Dawson's diagrams.

In the last page of his criticism Mr. Dawson points to his "careful examination and selection of specimens, etc., of Eozoon, in comparison with the works of others who arrive at conclusions in easier ways," and he concludes with the words: "Taken with the above cautions and explanations, the memoir of Professor Möbius may be regarded as an interesting and useful illustration of the structures of Eozoon, though from a point of view somewhat too limited to be wholly satisfactory." I here warn every naturalist who has not seen my memoir, not to think that it is an illustration of the organic nature of Eozoon.

The final result of my paper, that the Eozoon can not be a protoplasmic organic formation, will be maintained until Principal Dawson declares that all specimens of Eozoon which he has given away are not genuine representatives of his *Eozoon Canadense*, and until he has put into the hands of naturalists who are well acquainted with the structure of Foraminifera the genuine representatives of his *Eozoon Canadense*, which shows that organic nature sustained by Carpenter and himself. If he will kindly send me such representatives of his *Eozoon Canadense*, I will willingly forgive him that he has disappointed me and other naturalists. I will examine those genuine specimens with the same care and conscientiousness; and if I find a true organic structure, I will avow, without hesitation, that the genuine *Eozoon Canadense* was an animal. The aim of all my researches is this: not that I should be the one to find the truth, but that the truth should be found and brought to the light. No error will be changed into truth by constantly believing, nor by persistently declaring, it as truth.