

ART. II.—*Remarks on Dictyophyton, and descriptions of new species of allied forms from the Keokuk Beds, at Crawfordsville, Ind.*  
By R. P. WHITFIELD.

In the Am. Jour. Sci. for July 1881, I published an article on the fossil bodies known as DICTYOPHYTON described and figured in the 16th Report State Cab., New York, stating that they were probably more nearly related to the modern glass sponge *Euplectella* than to marine plants, to which group of organisms they had been referred by the author of the above mentioned genus. At the time the article appeared I had no positive proof of their spongoid character, and only inferred this to be the case from the general form of these bodies; from the similarity of the net-work composing them, and from their power to resist the trituration and maceration in sea water, which they necessarily must have undergone while being imbedded in the sandstones in which they are almost universally found preserved. In speaking of these features the following remarks are made. "If one examine the figures of the various species described, given on Plates 3 to 5 A of the above cited work, it will be seen that these bodies are more or less elongated tubes, straight or curved, cylindrical or angular, nodose or annulated; and that they have been composed of a thin film or pellicle of net-work, made up of longitudinal and horizontal threads which cross each other at right angles, thereby cutting the surface of the fossil into rectangular spaces; often with finer threads between the coarser ones. When the specimens, which are casts or impressions in sandstone, are carefully examined, it is found that these threads are not interwoven with each other like basket work, or like the fibers of cloth, nor do they unite with each other as do vegetable substances; but one set appears to pass on the outside, and the other on the inside of the body. The threads composing the net-work vary in strength, and are in regular sets in both directions, while the entire thickness of the film or substance of the body has been very inconsiderable. In one species, the only one in which the substance filling the space between the cast and the matrix has been observed, it appears to be not more than a twentieth of an inch in thickness, and is ochreous in character.

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This peculiar net-like structure does not seem to be that of any known plant, nor does their nodose, annulated, cylindrical or often sharply longitudinally angular form, with nearly perfect corners, indicate a vegetable structure; moreover, it is not a feature likely to be retained in a soft, yielding vegetable body of such extreme delicacy and large size, while drifting about by the action of water, in becoming imbedded in the sand of a sea bottom, but would rather indicate a substance of considerable rigidity and firmness of texture."

"In examining the structure of *Euplectella* it is found to be composed of longitudinal and horizontal bands similar to those above described, with the additional feature of sets of fibers passing in each direction obliquely across or between the longitudinal and horizontal sets, but not interwoven with them; so that the longitudinal series forms external ribs extending the length of the sponge, and the horizontal series inside ribs or bands, and they appear as if cemented to each other at their crossings. The oblique threads, besides strengthening the structure, cut across the angles of the quadrangular meshes formed by the two principal sets of fibers, and give to them the appearance of circular openings, making the structure much more complicated than in *Dictyophyton*. The addition of oblique fibers in *Euplectella* is the most noticeable difference between the two forms; but if placed horizontally and longitudinally between the primary sets they would produce precisely the structure seen in *Dictyophyton*."

"As yet we have no positive evidence of the nature of the substance which composed the fibers in *Dictyophyton*. The only cases known, so far as I am aware, of the preservation of the substance of the fossil is that mentioned above, where the space between the matrix and the cast is occupied by a ferruginous body, a material which so often replaces siliceous organisms in a fossil state, and specimens of *D. Newberryi* from Richfield, Ohio, on which there occur slight patches of a carbonaceous substance, but not sufficient to warrant the conclusion that it ever formed a part of the structure, even in the opinion of the author of the genus, who supposed these organisms to have been of vegetable origin; especially as they are associated with numerous fragments of terrestrial plants. I am therefore led to the opinion, from

their firmness of texture as evinced by the strong markings left in the rock, and the almost perfect retention of their original form that they were of a siliceous nature. Still, in this opinion I may be mistaken, and it must be left for future discovery to determine; but that they were of the nature of sponges and not of plants I feel very confident."

After the above remarks were in the hands of the printer, I had an opportunity of discussing the nature of these organisms with Principal Dawson, of Montreal, during which we examined some fragmentary specimens from the Keokuk beds at Crawfordsville, Indiana, which had but recently come into the possession of the Am. Mus. of Nat. History, on which is retained some of the substance of the net-work. Under a hand glass of moderate power this substance appeared to be made up of cylindrical threads of various sizes, composed of pyrite. With the means then at hand it was not possible to fully determine their character; but from microscopical examinations made more leisurely, the following notes were furnished me by Professor Dawson, and were printed with additional remarks by myself in the August number of the Am. Journal.

*Note by Dr. J. W. DAWSON on the Structure of a specimen of Uphantania, from the Collection of the American Museum of Natural History, New York City.*

To the naked eye the fossil presents rectangular meshes of dark matter on a gray finely arenaceous matrix. The spaces of the net-work are of an average of  $6^{\text{mm}}$  in length and 4 or 5 in breadth. The longitudinal bands are about  $3^{\text{mm}}$  broad, the transverse bands much narrower. Some of the rectangular interspaces are of the color of the matrix; others wholly or partially stained with dark matter. The meshes are nearly black, but in a bright light show a fibrous texture and metallic lustre due to pyrite.

Viewed as opaque objects under the microscope, the reticulating bands are seen to be fascicles of slender cylindrical rods or spicules, varying much in diameter; some of the largest being in the narrow transverse bands. The spicules may, in a few cases, be seen to be tapering very gently to a point, but usually seem quite cylindrical and smooth. In their present state they appear as solid shining rods of pyrite. The largest spicules are about  $\frac{1}{300}$  of an inch in diameter; the smaller scarcely one-fourth of that size. The spicules of the transverse bands cross those of the

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longitudinal ones without any organic connection. Among the long spicules of the bands can be seen multitudes of very minute and apparently short spicules confusedly disposed, and these abound also in the dark-colored areoles.

On the whole the structures are not identical with those of any plant known to me, and rather resemble those of siliceous sponges of the genus *Euplectella*.

The most puzzling fact in connection with this view is the mineral condition of the spicules now wholly replaced by pyrite. Carbonaceous structures are often replaced in this way, and so are also calcareous shells, especially when they contain much corneous matter, but such changes are not usual with siliceous organisms. If the spicules were originally siliceous, either they must have had large internal cavities which have been filled with pyrite, or the original material must have been wholly dissolved out and its place occupied with pyrite. It is to be observed, however, that in fossil sponges the siliceous matter has not infrequently been dissolved out, and its space left vacant or filled with other matters. I have specimens of *Astylospongia* from the Niagara formation which have thus been replaced by matter of a ferruginous color; and in a bundle of fibers probably of a sponge allied to a *Hyalonema* from the Upper Llandeilo of Scotland, I find the substance of the spicules entirely gone and the spaces formerly occupied by them empty. It should be added that joints of Crinoid stems and fronds of *Fenestella* occurring in the same specimen with the *Uphantania* are apparently in their natural calcareous state.

Though I have hitherto regarded this curious organism as a fucoid, I confess that the study of the specimen above referred to inclines me to regard it as more probably a sponge.

I owe the opportunity of examining this very interesting specimen to the kindness of Professor Whitfield.

The establishment of the fact, that spiculæ resembling those of sponges formed the substance of these bodies, proves conclusively that they were not of vegetable origin, and is equally conclusive that they were spongoid, while their general form and net-like structure will certainly place them near the recent genus *EUPLECTELLA*.

As early as 1842, Mr. T. A. Conrad described one of the principal forms of this group of organisms under the name *HYDROCERAS*, apparently under the supposition that it was a cephalopod, allied to the *Orthocerata* (Jour. Acad. Nat. Sci. Phil., p. 267, pl. 16, fig. 1), and in the Rept. 3d Dist. Geol. Surv. New York, p. 183, 1842, Prof. L. Vanuxem mentions and figures another 1881.]

form under the name *Uphantænia Chemungensis*. So far as I am aware no further notice was taken of them until the publication in the 16th Rept. State Cabinet of New York, where there is an extended notice of them given, and the generic name *Dictyophyton* (*woven plant*) proposed, and a number of new species described and figured. In this article the author refers them to the Vegetable Kingdom, with the remark that "they are algæ of a peculiar form and mode of growth." The name *Hydroceras* being discarded on account of its apparent objectionable signification.

In the Quar. Jour. Geol. Soc. London, 1862, p. 325, Professor Dawson gives a figure of *Hydroceras tuberosum* Con. and also mentions *Uphantænia Chemungensis* Vanuxem; but at that time considered them as probably marine plants.

In the synopsis of British Palæozoic Fossils, p. 62, Prof. McCoy describes what appears to be a species of *Dictyophyton*, (see pl. 1 D, figs. 7 and 8), under the name *Tetragonis Danbyi* Salter's sp. apparently referring it to the same group with *Receptaculites* as Salter had previously done in manuscript. The genus *Tetragonis* sp. *Murchisoni* was described by Eichwald in the "Urwelt Russlands," p. 81, 1841-43, which I have not been able to consult. But in 1860, in the *Lethæa Rossica*, p. 430, he describes the same species without figure, but from the description, as well as those of two other species of the genus figure, there is no doubt of the very close resemblance of all of them to *Receptaculites*. Nevertheless both McCoy—*loc-cit*—and subsequently Salter himself refers the English species, apparently a true *Dictyophyton*, to Eichwald's genus. At a much later date Mr. Salter in his catalogue of Camb. and Sil. fossils in the Cambridge Mus. places *Tetragonis* (figuring *T. Danbyi*) under the head of sponges, but without any remark, which I had not noticed until the present writing.

In 1879 Prof. H. A. Nicholson in the 2d Ed. of his Manual of Palæontology, Vol. 1, p. 128, seems to consider *Tetragonis* as a Foraminifer, at least after discussing the genus *Receptaculites* under that head he says: "In any case the Silurian genera described under the name *Ischadites* and *Tetragonis* are certainly the same as *Receptaculites*." It would therefore seem that the name *Tetragonis* cannot enter into competition with others, in point of priority, as applied to these bodies. Still there are three

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other names up to the date of Prof. Nicholson's work applied to them : *Hydnoceras*, *Uphantania* and *Dictyophyton*.

In the same year with Nicholson's Manual, 1879, Mr. C. D. Walcott published in Vol. X of the Trans. Albany Inst., p. 18 Ext., the genus *Cyathophycus* for some similar bodies from the Utica Slate, which even more closely resemble *Euplectella* than those above mentioned, although he at the time considered them as Plants, but has since corrected the reference, see Am. Jour. Sci., Nov., 1881, p. 394. This leaves four American generic names applied to forms of this group which do not appear to me to be more than specifically distinct ; inasmuch as they are all composed of threads or bands crossing each other at right angles, in the same general direction, forming the same kind of net-work in all, leaving the external form or shape to constitute their specific individualities. The two later names applied, viz., *Dictyophyton* and *Cyathophycus*, are both misnomers, if the spongoid nature of the organisms is considered as established, while the two former *Hydnoceras* and *Uphantania* do not imply any zoological or botanical feature, although the first was given under a false impression. It may therefore be necessary to go back to one of the earlier names proposed.

The forms described by Mr. Walcott under the name *Cyathophycus* are the oldest forms geologically yet known, being from the Utica Slate. The English forms given by McCoy and by Salter are from the Upper Ludlow rocks of England, supposed to represent the higher parts of our Lower Helderberg beds, although they contain many representatives of our Hamilton and other Devonian forms of fossils. So far as yet known no forms have been discovered in American rocks between the Utica Slates and the Chemung, where there are several species. They occur in the Waverly of Ohio and in the sandstone at Burlington, Iowa, and are known in six different species from the Keokuk beds of Crawfordsville, Ind.; so their geological range can be said to be from the Lower Silurian to the Lower Carboniferous. The example on which the spiculæ were first observed, and subsequently examined by Prof. Dawson, is somewhat related to Vanuxem's *Uphantania* in its broad bands, and was at first supposed to be part of a flat circular frond, being so described in the Am. Jour.

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Sci., but on further examination was found to bend over at the sides and to pass into the rock beneath ; and on clearing away the matrix from below was found to be a broadly spreading cup, the opposite side showing obscurely when cleared from rock. A second specimen subsequently procured from Prof. John Collette, State Geologist of Ind., which was evidently of the same species, had a distinctly cylindrical form, so that the form would appear to be somewhat variable. In the August number of the Am. Journal above mentioned, I proposed for it the name *Uphantenia Dawsoni*, which I shall retain, and now give the following description of its character.

UPHANTÆNIA DAWSONI,

Plate 4. Figs. 1 and 2.

*Uphantenia Dawsoni*, Whitf., Am. Jour. Sci., August. 1881, p.

General form of body broadly cyathiform above, with probably a cylindrical stem of varying dimensions below. Structure composed of longitudinal and horizontal bands, crossing each other at right angles, leaving rectangular spaces between. The longitudinal bands are of two kinds, one broad, the other narrow, alternating with each other, and varying in size according to the dimensions of the body, often attaining a width of three-sixteenths of an inch, while the intermediate ones seldom exceed one-sixteenth of an inch in width. Horizontal bands narrow and equal. Spaces between the rays rectangular, varying from higher than wide to once and a half as wide as high.

The arrangement of wide and narrow longitudinal bands gives two vertical rows of rectangular spaces between each broad band, and the individual spaces in the two rows alternate with each other in being raised or depressed above or below the general surface of the bands, so that they alternately form a node or depression on the surface as shown on the rock. These spaces are covered by a thin film of the same substance as the bands where perfect, but the depressions are usually filled, and the raised node broken in separating the specimen from the matrix, so that the remains appear like a network of bands with rectangular openings in its substance. The appearance however when the

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nodes and depressions are preserved is much like what would be presented by a fabric in which there were elastic bands, which when contracted would wrinkle up the intermediate portions.

When the specimens of this species, as well as others from the same locality, are examined under a magnifier, they are seen to be composed of a dark pyritous film, and when more highly enlarged this is easily resolved into innumerable slender, thread-like spiculæ, as mentioned in Prof. Dawson's notes, given above. The threads of the narrow transverse and longitudinal bands are large and stronger than those of the broad bands, but have finer intermediate threads among them. The film coating the interradiar spaces is composed of a still finer set of spiculæ than the principal ones in either set of rays or bands; under a strong glass they are seen to be arranged in both a transverse and longitudinal direction on different parts of the area, which arrangement gives them a radiating appearance from the centre of a node. It is possible that this species ought not to be placed under the genus *Uphantania* on account of its cylindrical or cup shaped form, but as the bands so closely resemble those of the type species and are quite unlike those of *Dictyophyton*, I prefer to leave it under that genus until something further is known in regard to the true form of the type species. So far as I can ascertain, the original specimen does not show any indications of striæ or other marking on the surfaces of the band-like impressions, to indicate the existence of spiculæ or threads, but from its general resemblance to parts of *U. Dawsoni*, here described, I have no doubt whatever of their generic identity.

Among the fossils in the museum from the Keokuk beds of Crawfordsville, Ind., there are remains of three or four other species of these peculiar bodies, and among them the one described below is perhaps the most interesting and instructive, and illuminates, perhaps, more distinctly their true form and relations than any other specimen yet discovered except *D. coronatum*, described below. Its probable cylindrical base, with a convex sieve-like cap surrounded by an expanded frill, will at once call to mind, to those familiar with *Euplectella*, its close resemblance to the upper part of that beautiful form although on a somewhat larger scale.



## DICTYOPHYTON CATTILIFORME, N. sp.

*Plate 3. Fig. 1.*

General form of body that of a short, broad tube or cylinder, which may be slightly expanded downward, and is capped above by a more or less convex cover or dome, from the margin of which at its junction with the cylindrical portion, there extends a broad, more or less undulated, horizontal flange or frill-like rim. The lower or cylindrical part is composed of longitudinal (vertical) ribs or threads, crossed by finer and much more closely arranged horizontal or transverse threads, and is strengthened in the upper part, apparently, by strong undulations or folds extending to near the lower part, where they gradually die out. The dome and rim is composed of a series of radiating threads which extend from the centre to the margin of the frill-like rim on every side, increasing in strength as they approach the outer parts, while their relative distance from each other is partially maintained by the addition of new rays between the original ones. This feature also gives them a somewhat alternately stronger and finer character. The radiating threads are crossed by a system of circular threads in rings, somewhat increasing in distance from each other from the centre outward, those in the frill being most distant.

The central part of the summit or dome is moderately depressed-convex, more abruptly bent downwards at the edges where it forms a junction with the cylindrical portion below, and from which point the frill-like expansion rises ; so that the constriction distinctly marks the line of junction, and gives the diameter of the cylindrical stem of the body. The specimen used and of which the figure given is natural size, is somewhat obliquely crushed in the lower part so that the cylindrical portion is flattened and pressed out on one side, making it appear broader than it actually was in life. Its line of bedding in the rock is readily traceable at the opposite end of the specimen, and the rock is fractured along the line of constriction between the dome and frill, showing its existence all round. The summit was embedded horizontally in the rock and is but little compressed. The present form is somewhat regularly oval, the dome having a diameter of nearly four and one-half by almost six inches, while the rim varies from one and one-fourth to almost two inches in width.

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The disc is imperfect on one side, but the portion below where the cylindrical part is shown beneath in the figure is preserved, and was purposely removed to show the connexion of the lower part with the discoid top of the organism. The dotted line, *aa*, shows the margin of the rim when the removed parts are in place. No spiculæ are preserved on this specimen, but the rock is colored by the decomposition of pyrites, and the surface in many parts, especially near the upper end of the cylindrical portion, is densely covered by small round grains of gypsum, which were at first thought to be part of the organism until they were found common on many other fossils from the same locality, and are probably the result of the action of the sulphur from the pyrite on the lime of the rock. Another species which is described below under the specific name "*cylindricum*," preserves the spiculæ in the most beautiful and distinct manner.

DICTYOPHYTON CYLINDRICUM. N. sp.

*Plate 4. Fig. 3.*

Body so far as known cylindrical, and destitute of any distinct markings or ornamentation, so far as can be seen by the unaided eye; but apparently formed of a thin compact film. But under a magnifier it is seen to be composed of longitudinal and transverse fibers or threads, which give a finely reticulate texture. When more highly magnified the substance of the threads is seen to be composed of bundles of cylindrical spiculæ of various sizes and of great length. Those forming the longitudinal threads are strong, with finer intermediate threads, and pass mostly along the outer surface, while the transverse portions are very fine and seem mostly to be on the inner surface of the substance.

The specimen of this species used is a flattened cylinder about three inches in length by more than two inches in width as it lies on the rock, but is imperfect at each end and is apparently a fragment only. It is to the unaided eye destitute of markings, but presents a compact leathery surface. The spiculæ are very large and very numerous, and are quite direct in their course along the tube or transverse to it, crossing each other at right angles; but after careful examination I do not find any of them interwoven

like the threads of a piece of cloth. The one fiber seems to pass over the other at one place, continuing to do so as far as it or its imprint can be traced on the specimen.

Beyond the three species here described there are fragments of three others from the same locality in the Museum collection, but as they are all so imperfect as not to give any definite indication of their complete form, I shall not describe them at the present time, the last named one, *D. cylindricum*, being used on account of its very distinct and perfectly shown spiculæ. Representatives of the species are in the museum collection.

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ART. III.—*Observations on the purposes of the embryonic sheaths of Endoceras, and their bearing on the origin of the siphon in the Orthocerata.* By R. P. WHITFIELD.

The genus ENDOCERAS was proposed in 1847 for a group of fossil Cephalopods, belonging to the ORTHOCERATIDÆ, which presents the anomalous feature of a series of invaginated, conical sheaths, occupying the cavity of the siphon. When the genus was proposed, these sheaths were supposed by its author, to be of the nature of embryonic sheaths designed for the retention and protection of the young shells while they were yet within the body of the parent. The existence of such a feature in an animal, of course, presupposes that animal to be viviparous in character, and the announcement of such a feature existing in a cephalopod was entirely unexpected and novel; and consequently attracted considerable attention among naturalists of the day, especially of those studying Palæontology; and there is perhaps no one feature of the fossil Cephalopoda which has given origin to so much discussion, or about which so much has been written as the supposed purposes of these so called embryonic sheaths of the ENDOCERAS. Most of the Palæontologists of note in Europe, writing within several years of its announcement, expressed their opinions of their nature; and most of them adversely to their embryonic

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