

## TWO NEW SPECIES OF ALGÆ OF THE GENUS BUTHOTREPHIS, FROM THE UPPER SILURIAN OF INDIANA.

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The specimens which form the subject of this paper were collected by Mr. C. E. Newlin from the Eurypterid beds at Kokomo, Indiana, and were communicated by Dr. E. M. Kindle, assistant State geologist. The Eurypterid beds are correlated with the Rondout of Schuchert and Clarke, and the fossils are therefore nearly contemporaneous with the closely allied species *Buthotrephis lesquercurii* Grote and Pitt, from the Waterlime of western New York.

The original of Plate XVII, *Buthotrephis newlini*, is in the Paleozoic plant collection of the U. S. National Museum. The type of *B. divaricata*, Plate XVI, is in the private collection of Mr. Newlin in Irvington, Indiana.

The characters of the specimens in hand will first be described before entering upon a discussion of the nature or affinities of the genus *Buthotrephis*.

### BUTHOTREPHIS DIVARICATA, new species.

(Plate XVI.)

Fronds very openly fasciculate from a broad attachment; lamina relatively broad, sinuately curved, two or three times dichotomous, beginning near the base, the distance between the bifurcations being about three times the width of the lamina, which is of nearly equal breadth at all points; divisions and lobes divaricate, usually at a wide angle, and outward curved; lobes rounded or round-truncate at the apex, which is slightly denser; carbonaceous residue thin, rugulose or minutely granulose, and marked, especially along the medial portion, by very delicate, irregularly, but more or less obliquely, arranged trichomatose or filamentose (?) impressions.

The aspect and general features of this well-marked species are well shown in the photographic illustration, Plate XVI, which represents the only specimen of this type communicated. The most salient characters are the divaricate position of the subdivisions of the frond at

the frequent and equal dichotomies; the continuity in width of the lamina, which is without a central axis or strand; and the very obtuse, slightly thickened apices. The greater density or more compact organization of the latter is shown by the slight increase of the carbonaceous residue. In many of the lobules the impressions seem to indicate groups of compressed, nearly contiguous, globular bodies, the largest of which, shown in the upper portion of the figure, attain a diameter of about 2 mm. These globules (?), of varying size, appear in some cases to occupy nearly the entire apex of the lobe. The impressions, which are less distinct in passing downward along the center of the lobe, are at best a little vague. It is possible that they are due only to the mode of cleavage in the denser carbonaceous residue; but it seems probable that they owe their presence to differences in the composition of the lamina. They are suggestive of the sporangia in the lobes of the living *Fucus*.

BUTHOTREPHIS NEWLINI, new species.

(Plates XVII, XVIII.)

Fronds fasciculate from a rather thick, scarcely axial base, the divisions forking generally distantly, but equally or nearly so, or sometimes subfasciculately, at a moderate or wide angle, the lobes often linear, sometimes terminally bifurcated, obtusely rounded and denser at the apex; lamina of nearly constant width, though narrowing slightly for a distance below each bifurcation; texture slightly rugose, marked by irregular, very slender, intermingled and tangled trichomatose or filamentose elements, those near the center being coarser, often threadlike, and more or less longitudinal in their arrangement.

This species has much in common with *Buthotrephis lesquerenzii* Grote and Pitt, from which it is distinguished by its narrower and much more frequently forking divisions, the divisions of the latter species being much elongated and very distantly forked.

The trichomanose or rather coarsely tomentose character is distinctly visible in the impression of the lower portion of the plant as well as at the apices of the lobes. In the lower portion of the frond it appears to be produced by a tangle of filaments suggestive of the texture of felt cloth, although those nearer the middle of the lamina are coarsest. A similar texture is seen in *Buthotrephis lesquerenzii* and, with finer filaments (?), in *B. divaricata*. In the lower part of the main division on the right in Plate XVII some of the coarse fibroid filaments (?) are by the aid of a weak lens clearly seen on the surface of the carbonaceous residue. No trace of fructification is recognizable.

The fragment illustrated in Plate XVIII is here regarded as a more delicate or perhaps younger example of the *B. newlini*, although the more slender proportions of the divisions and the more delicate texture possibly merit a varietal distinction. The surface is of the same

general character as that of the original of Plate XVII. In portions of the impression it presents a slightly irregularly woven or cloth-like mesh strikingly suggestive of the spongy composition of the living *Codium*.

The genus *Buthotrephis* was described in 1847 by Hall<sup>1</sup> as an alga characterized by "Stems subcylindrical or compressed, branched; branches numerous, divaricating, leaf-like; structure vesicular!" The species *Buthotrephis antiqua*,<sup>2</sup> from the Calciferous sandstone at Chazy, New York, generally cited as the type of the genus, is a distinctly algal form with a narrow, flattened lamina, irregularly branching at a wide angle along the imperfectly defined axis, and dichotomous in the upper part, with more or less acute, narrowly lanceolate or sub-falcate lobes or ultimate divisions. *Buthotrephis gracilis*, the form described by Hall<sup>3</sup> as typical of the genus, resembles a linear-leaved *Potamogeton*. It presents an axial development, although the divisions fork and are slightly recurved.

In form, aspect, and even in their supposed vesicular structure the Kokomo types appear undoubtedly to belong to the group of narrow forms originally included by Hall, on the basis of their superficial characters, in *Buthotrephis*. It is, however, understood by all paleontologists that the discovery of the reproductive organs in the various species of this artificial genus may necessitate their ultimate reference to more than one family as well as to several genera. Of Hall's species, that most closely resembling the plants in hand is the *B. succulens*<sup>4</sup> from the Trenton at Glens Falls, New York. The latter agrees in its dichotomizing fronds, lax habit, nearly constant width of the lamina in passing upward, and the blunt apices of the lobules, though differing, especially from *B. divaricata*, by the more distant bifurcations, and the less divaricate position of the branches and lobes, while the latter are terete and less truncate. The enlarged apices of *B. newlini* suggest the *B. impudica* Hall,<sup>5</sup> from the Clinton, though the same feature is slightly apparent in *B. palmata*, whose general plan recalls that of *B. divaricata*. *Buthotrephis subnodosa* Hall,<sup>6</sup> from the Hudson River group, like the *B. gracilis*, has a somewhat elongated or axial form of development,<sup>7</sup> though the lateral divisions are dichotomous.

Of all the species as yet ascribed to this genus that which seems to be most closely related to the fossils in hand is the *Buthotrephis les-*

<sup>1</sup> Paleontology of New York, I, p. 8.

<sup>2</sup> Idem., I, p. 8, pl. ii, fig. 6.

<sup>3</sup> Idem., I, p. 62, pl. xxi, fig. 1.

<sup>4</sup> Idem., I, p. 62, pl. xxii, fig. 2.

<sup>5</sup> Idem., II, p. 20, pl. vi, fig. 2.

<sup>6</sup> Idem., I, p. 262, pl. lxxviii, fig. 3.

<sup>7</sup> Certain of the elongated forms of the genus might with convenience in classification be set apart as a distinct section.

*quereaurii* described by Grote and Pitt<sup>1</sup> from the Waterlime near Buffalo, New York.

The examination of specimens of this species in the collections of the U. S. National Museum shows it essentially to differ from *B. newlini* only by its more robust, linear, and more rarely forked divisions. The texture is of precisely the same character, though the filamentous (?) elements are less distinct.

On account of the relatively large amount of carbonaceous residue and the slightly rugose or vesicular texture, which is in strong contrast to the delicate film, smooth impression, noncarbonaceous cast, or the coralline residue of most fossil algae, those forms with the characters of the types in hand or of *Buthotrephis lesquereaurii* are regarded by many paleontologists as probably representing sponges. Neither of the specimens described above, which have been submitted to a number of experts<sup>2</sup> in Paleozoic invertebrate paleontology, nor the examples of the species last mentioned, appear to reveal a sponge structure or the normal occurrence of sponge spicules. The evidence in support of a sponge relationship for these organisms appears therefore to lie in their dense, apparently vesicular texture, and their occurrence in distinctly marine beds and in association with a marine fauna.

It is not the purpose of the writer to strenuously urge that these fossils are marine algae, although he believes them to be such. The evidence, or perhaps to speak more accurately, the circumstances which point toward a place for these types among the marine algae are: (a) The marine habitat; (b) the typically algaloid form of development and growth, and (c) the aspect of the residue. All of these features may pertain to a fossil sponge; yet the absence of a regular sponge structure, and especially the lack of spicules in these well-preserved specimens, argues somewhat strongly against a reference to a sponge group. Without such characters these fossils can not safely be referred to that class of organisms. On the other hand, the reference of the forms from the Waterlime to the algae can not be conclusively demonstrated, since neither the histology nor the fructification is known. Evidence of this class, though most important, is, however, wanting in most of the fossil types whose thalassophytic nature is generally admitted, although the immediate systematic classification of the latter is usually artificial and largely conjectural.

There are many types of living algae representing various genera and even families with which the *Buthotrephis* group may with interest be compared. One of these which, in the judgment of the writer,

<sup>1</sup>Bull. Buffalo Soc. Nat. Hist., III, 1876, p. 88.

<sup>2</sup>The thanks of the writer are due to Mr. Charles Schuchert, of the U. S. National Museum, and Mr. E. O. Ulrich and Dr. George H. Girty, of the U. S. Geological Survey, for their courtesy in examining the fossils from Kokomo with a view to the detection of sponge characters.

demands most consideration is the genus *Codium* Stackhouse, to which reference has already been made in the description of *Buthotrephis newlini*. In *Codium* we find sponge-like fronds which may be simple or branched, and which are composed of a mass or plexus of innumerable slender, inextricably tangled or interwoven and irregularly branched unicellular filaments whose ramules form the surface of the frond. Near the center of this mass of curled and branched filaments which gives form to the frond, the individual filaments are often threadlike and sometimes largely longitudinal. The more or less club-shaped ramuli radiate outward and are contiguous, though not united, so as to constitute the periphery of the frond. The fructification of *Codium* is contained in oval or ovate sporangia laterally situated near the bases of the ramules. It is hardly to be expected that such sporangia, enshrouded by ramules, would be discernible in carbonized and compressed specimens except by a most favorable accident of preservation. The analogy between the impression of or the residual surface of the spongoid *Buthotrephis* and the texture of *Codium* is forcibly suggestive; and although the stronger, apparently central, filaments (!) of *B. newlini* (Plate XVII, *a*) are coarser than any to be seen in such specimens of the dried *Codium tomentosum* as the writer has had for examination, the comparison of the specimens can hardly fail to raise the question as to whether the general structure and nature of the organisms are not essentially the same. In some species of *Codium* the filaments are often somewhat regularly meshed, so that the surface suggests a loosely though irregularly woven cloth-like structure. It is worthy of mention that in *Udotea* Lamouroux, which stands next to *Codium* in the *Codiaceæ*, the frond bears a calcareous incrustation, while in *Halimeda* Lamouroux, another genus of the same family, we find a false epidermis, though the filamentose internal composition of the plant is like that of the other genera of the family.

It is not the object of this discussion to argue that the *Buthotrephis* types under consideration are to be conclusively regarded as belonging to or, at least, as closely allied to the *Codium* group of the Siphonous *Chlorophyceæ* (green algæ), or even that they are indisputably proven to be algæ; it is to call attention to the fact that we have among the algæ, notably in the *Codiaceæ*, types which would seem calculated, under favorable circumstances of fossilization, to present characters of form, aspect, and carbonaceous texture similar to and perhaps essentially the same as those of *Buthotrephis*. The specimens in hand appear, so far as their characters are revealed, to conform to and to be admissible to the algæ, there being no inherent evidence to the contrary.<sup>1</sup> A reference of these forms to the sponges would there-

<sup>1</sup>It is possible that a slight calcareous envelope, comparable to that of *Udotea*, might assist in preserving both the form and the substance in the algæ of this group.

fore appear, in the absence of distinctive sponge characters, to be unwarranted at present.

It may not be improper in this connection to add that certain of the organisms generally though doubtfully ranged with the Graptolites might be more at home among the algae.<sup>1</sup>

Among other living algae whose form is comparable to that of *Buthotrephis*, though agreeing less closely in texture, the genus *Lia-gora* (*L. corymbosa* J. Agardh) may be mentioned, while among the fossil types fronds resembling in a general way those under consideration are found among the abundant Eocene species of *Chondrites*, some of the remains of which are rather densely carbonaceous.<sup>2</sup>

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#### EXPLANATION OF PLATES XVI-XVIII.

BUTHOTREPHIS FROM THE EURYPTERID (RONDOUT) BEDS AT KOKOMO, INDIANA.

##### PLATE XVI.

*Buthotrephis divaricata* David White. Natural size. Collection of C. E. Newlin, Irvington, Indiana.

##### PLATE XVII.

*Buthotrephis newlini* David White. Natural size. *a.* Enlarged detail showing filamentose texture (x4). Collection of the U. S. National Museum. Cat. No. 8175, U.S.N.M.

##### PLATE XVIII.

*Buthotrephis newlini* David White. Form with narrow thalli. Natural size. Collection of C. E. Newlin, Irvington, Indiana.

<sup>1</sup>The texture of the forms from Kokomo and the Buffalo Waterlime appears to have much in common with some of the specimens now resting in or near *Inocaulis*.

<sup>2</sup>See *Chondrites dolichophyllus* Squinabol, Contrib. Fl. foss. Terz. Liguria, pt. i, Alghe, pl. B.



*BUTHOTREPHIS DIVARICATA* DAVID WHITE.

FOR EXPLANATION OF PLATE SEE PAGE 270.







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