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1. *On the OCCURRENCE of EDESTUS in the COAL-MEASURES of BRITAIN.*
By EDWIN TULLEY NEWTON, Esq., F.R.S., V.P.G.S.¹ (Read
November 18th, 1903.)

[PLATE I.]

THE presence of marine beds in the Coal-Measures of North Staffordshire was first made known by Mr. J. Ward [1],² of Longton, in 1865; but their occurrence in other districts had already been observed by the officers of the Geological Survey [2 & 3].

These marine bands are chiefly met with during the sinking of shafts; and Mr. J. T. Stobbs, F.G.S., of Stoke-on-Trent, has for some time past been studying those that occur in North Staffordshire. It is due to the vigilant observations of that gentleman, and to the assistance of the pupils of his mining class, that these beds are found to occur with much greater frequency than has hitherto been supposed.

Mr. Stobbs very courteously called the attention of the Geological Survey to one of these marine bands, found at about 18 yards below the 'Twist Coal,' in the Smallthorne sinking of Messrs. Robert Heath & Son's pits at Nettlebank (North Staffordshire).

An interesting series of fossils has been found in the shales and impure limestones brought to bank from this particular band; and with the permission of the colliery-owners, the fossil-collector of the Geological Survey, Mr. J. Pringle, went to Smallthorne to secure a series of these fossils. Among the specimens thus obtained, there is one which calls for special notice, as it establishes for the first time the occurrence in Britain of the remarkable genus of fishes known as *Edestus*. This genus was originally described

¹ Communicated by permission of the Director of H.M. Geological Survey.

² These numbers in square brackets throughout the paper refer to the bibliographical list on p. 7.

from the Coal-Measures of the United States, but was afterwards recognized in beds of similar age in Russia and Australia. The accompanying figure (fig. 1, below) of the first-described specimen (*Edestus minor*) will call to mind the form of this ichthyodorulite, which has been thought to be a dorsal defence. To it have also been assigned various other functions in the economy of the fish to which it belonged; its true nature, however, remains uncertain.

The segmented character of *Edestus minor* is shown in this figure; and separate segments of this and other species have been met with in North America, showing that each tooth was attached to a firm base, elongated in one direction and grooved above for the reception of the under part of a similar segment. Several such segments were united in the original specimen.

Fig. 1.—Side view of *Edestus minor*. ($\frac{1}{2}$ nat. size.)

[From Geol. Surv. Illinois, vol. iv (1870) pl. i, fig. 2.]

A = Anterior, oldest segment.

B = Posterior, newest segment.

It is now more than 48 years (August 1855) since Hitchcock [4] first made known the remains of the remarkable fish from the 'Coal-formation' of Park County (Indiana), to which Newberry [8] afterwards gave the name of *Edestus minor*. It was Leidy [5], however, who proposed the generic name of *Edestus* for a large and closely-allied form from the Coal-Measures of Arkansas, which he described under the name of *Edestus vorax*.

In the year 1870, Newberry and Worthen [9] made known another species, *Edestus Heinrichii*, from the Coal-Measures of Illinois. Up to that time the genus had only been known in North America; but in 1878 Dr. H. Trautschold [10] recognized, among the fossils described by him from Miachkova, near Moscow, a single denticle, referable to this genus, which he named *Edestus protopirata*; and subsequently, in 1884 [12], the same writer

A. T. Hollick del. et lith.

Mintern Bros imp

EDESTUS TRISERRATUS, nov. sp.

obtained, also from near Moscow, a more perfect specimen with a large part of its grooved basal segment: thus more firmly establishing the occurrence of the genus in Europe.

In 1886 Dr. Henry Woodward [14] described the remarkable ichthyodorulite from the Carboniferous rocks of Western Australia, to which he gave the name of *Edestus Davisii*. The specimen differed in several points from the forms hitherto referred to *Edestus*, more especially in its deeper curvature and in the larger number of its denticles; but Dr. Woodward was correct in regarding it as nearly related to *Edestus*, although it is now placed in a distinct genus.

Another species which, on account of its large size, received the name of *Edestus giganteus*, was described by Newberry [17] in 1889, from the Coal-Measures of Decatur, Macon County (Illinois); and in 1898 Dr. Bashford Dean [20] gave an account of another much-curved form, under the title of *Edestus Lecontei*, from the west of the Rocky Mountains, in Nevada.

In 1899, Dr. Karpinski [21] published his detailed memoir on the Edestidae and on a new genus, *Helicoprion*. Several examples of these 'spiral saws' had been found in the 'Artinskian stage' (Permo-Carboniferous) near the town of Krasnoi Ufimsk, in Eastern European Russia, a little west of the Urals. These extraordinary tooth-bearing spirals still remain an unsolved problem, notwithstanding the lively discussion to which Dr. Karpinski's memoir has given rise, and which continues to the present time, several eminent workers abroad and at home having expressed their views on the subject [see 27-31]. Not the least important of these contributions were the papers published by Dr. Eastman in 1901 and 1902 [22-26]. In one of these [24] a new genus, *Campyloprion*, is established for certain fossils closely allied to *Helicoprion*. In this, and the subsequent memoir, Dr. Eastman describes the *Orodus*-like jaw of *Campodus*, with its somewhat compressed and enrolled symphyseal series of teeth, which are regarded as of Cestraciont type, and are thought to indicate the principle of enrolling of the teeth on or near the symphysis, which culminated in the 'spiral saw' of *Helicoprion*; *Edestus* and *Campyloprion* showing intermediate stages, in which the teeth were broken off or worn away, instead of being retained and rolled into a spiral.

The presence of *Helicoprion* in the Carboniferous rocks of Japan has been made known by M. H. Yabe [32], and I am indebted to Dr. A. Smith Woodward for this reference.

The specimen, found by Mr. Pringle at Nettlebank, was, when it first came into my hands, in several pieces, and much of it was still hidden in the hackly, dark limestone.¹ The fossil itself being very brittle, the greatest care was necessary for its development; it is now, however, in a condition to show its complete form, with the exception of the point of the tooth, which was not found.

¹ Dr. W. Pollard, F.G.S., who has kindly examined the rock, says that it is an impure limestone, containing some magnesia and ferrous carbonate.

The specimen is evidently a single segment of a fossil very closely resembling *Edestus minor*, and consists of an elongated basal portion bearing at one extremity a smooth, enamelled, and serrated crown. The inferior border of the base is concave from end to end, and the superior border is convex in the same direction. Below the crown the base is flattened on each side and angular at the inferior border. This angularity becomes less marked towards the middle, and the lower border is then more and more rounded to the opposite end, this portion of the base being thicker and deeper than the part which carries the crown. Two or three vascular grooves are seen upon the side, extending from apertures which penetrate to the deeper parts of the base. The whole of the base has an open spongy texture, the interstices being filled with the dark matrix.

The line of demarcation between the crown and the base is clearly defined by the edge of the enamel, the roughness of the base increasing as it approaches this dividing-line, which is not quite parallel with the lower margin, but approaches it somewhat as it nears the extremity, and then, curving downward, the enamel completely embraces the end of the base, while beyond it extends the distal part of the crown.

The free cutting-edges of the crown, so far as preserved, are strongly denticulated, there being on the upper margin twelve denticles in 1.4 millimetres. A closer examination with a lens shows that each of these denticles is again divided into three serrations, the median one being about twice as large as the outer two. So much of the lower margin as is preserved shows six denticles in 5 millimetres, but there is no evidence of these being serrated.

The outer edge of the enamelled crown forms a narrow pointed spur, extending in the direction of the elongated base as far as the end of the upper denticulated cutting-edge, but separated from it by a tongue of the roughened base, which passes in between them for about a third of the length of the crown. Probably there is a similar spur of enamel on the opposite side of the tooth, but this is hidden in the matrix. The end of the crown being absent, its form cannot be known, but, judging from what remains, it seems to have resembled that of *Edestus minor*; the dotted line in Pl. I, fig. 1 gives a restoration on this basis.

Seen from the end, the crown is much compressed, and the section exposed by the broken surface is lenticular (Pl. I, fig. 6). Below the broken end the denticles extend quite to the lower margin, and on each side, just above the lowest denticle, is a little rounded cusp.

When the specimen is viewed from above, a deep trough is seen to extend throughout its length, excepting the portion occupied by the crown, close to which the trough descends about halfway into the thickness of the base, and becomes deeper as it passes away from the crown, occupying the whole depth at the opposite extremity. This end of the specimen has the two sides very unlike (see Pl. I, fig. 1), for, while the side next to the matrix ends in a rounded point, the side freed from matrix is deeply notched. A part

of this side has been accidentally cut away, but the notch is not due to this cause, for the fragment cut off is similarly, though not so deeply, notched. Some splinters of bone near by may, however, indicate that fracture took place before fossilization.

The upper view shows the specimen to be nearly equilateral, so nearly so indeed that the inequalities may be, and probably are, due to distortion, or imperfection, in fossilization. But this want of equality must not be lost sight of, for if such specimens be not practically equilateral, we lose the chief evidence for the median position of these ichthyodorulites in the fish to which they belonged.

MEASUREMENTS OF *Edestus* FROM SMALLTHORNE, IN MILLIMETRES.

Length of lower margin <i>a-b</i> , Pl. I, fig. 1.....	59.0
Height of base at <i>f-g</i>	12.0
Thickness of base at <i>f-g</i>	10.5
Height at <i>h</i> , Pl. I, fig. 3	11.0
Depth of groove at <i>h</i>	5.5
Lower edge of crown, <i>a-c</i>	18.0
Upper margin preserved, <i>c-d</i>	14.0
Lower margin preserved, <i>a-e</i>	5.0
Broken end of crown, <i>d-e</i>	8.0
Broken end of crown, thickness	2.3
Length of spur	7.0

The shape of the base below the crown and the form of the trough of the upper surface show clearly that this specimen is one segment of a series, fitting one into the upper groove of another, as in *Edestus*. And the close resemblance between this fossil and *Edestus minor* leaves no room for doubting their generic identity; but the question of species is more troublesome.

That our fossil is more nearly allied to *Edestus minor* than to any other known species of the genus is evident; but the want of a perfect crown prevents a completely-satisfactory comparison. The type-specimen of *Edestus minor*, described by Newberry, had a very little of the lower part of the crown or base preserved; but the upper part is lanceolate, and is described as having double denticles; this is unlike the Smallthorne fossil, which has the denticles in triple form. Hitchcock's original specimen (see text-fig. 1, p. 2), which was subsequently referred to *E. minor* by Newberry, has the crowns of the teeth rather more obtusely lanceolate than in the type, and each crown is said to have a lateral spur of enamel similar to that seen in the Smallthorne specimen, but the denticles are double. So far as one can judge of the form of a segment in *E. minor*, it is unlike this British fossil. The much smaller specimen from Moscow, referred by Dr. Karpinski to *E. minor*, has a narrower and more acuminate crown than either of the American specimens, but shows the same slender spur of enamel, and the denticles are said to be as in *E. minor*. The base below the crown is very like the same part in the Smallthorne fossil; but, on close comparison, it will be seen that the lower edge of the enamel forms nearly a straight line in the Russian tooth, while a

few of the lower denticles are at right angles with the rest of the crown. In the British specimen, on the other hand, the lower edge of the enamel is strongly bent, while the lower denticulated margin is only slightly curved at its lower end. There is likewise a difference in the denticles; the Russian specimen having them, as in *Edestus minor*, double and not triple.

Dr. Karpinski was evidently in some doubt as to his specimen being really an example of *E. minor*, for he says that it is either this or a closely-allied species, and I am inclined to think that the latter suggestion is the more justifiable. But, however that may be, the Smallthorne specimen can scarcely be referred to *Edestus minor*, the differences mentioned above preventing such a reference. Bearing in mind, therefore, the most striking peculiarity of our fossil, I propose to name it *Edestus triserratus*.

Fig. 2.—Segments of *Edestus triserratus* restored. ($\frac{3}{5}$ nat. size.)

A = Anterior, oldest segment. B = Posterior, newest segment.

Fortunately the basal portion of our specimen and its trough are so well shown, that the manner in which the segments fitted together is obvious; and, taking advantage of this, the appearance of half a dozen such segments combined is shown in text-fig. 2.

The crowns of all the teeth in Newberry's figure of *E. minor* are so nearly of the same size, that one is justified in assuming that the teeth and segments of our British specimens did not vary greatly in this respect, and consequently the combined series would have had much the appearance of my restoration; but probably the basal portions of the older segments of *Edestus* changed somewhat in shape by continued deposition or absorption of bony material. At first sight it is not clear which is the growing end of such a series. Among a large number of segments of *E. Heinrichsii* that Newberry had for examination was one which possessed no groove; and he concluded that this was the first of a series, that a new segment was formed with its base under the toothed

end of the older one, and that this by growth gradually ensheathed the one above. This seems most likely to be the correct interpretation, although doubt has been thrown upon the supposed non-grooved segment, which was thought to be the first formed.

That the curved and toothed ichthyodorulites, to which the name of *Edestus* is properly restricted, belonged to a fish closely allied to that which carried the 'spiral saw,' *Helicoprion*, is generally agreed, but it is by no means proved that the two forms had a similar function.

Dr. Eastman has shown good reason for thinking that the enrolling of the symphyseal teeth of *Campodus* is an indication of the nature of the spiral of *Helicoprion*, although he was not the first to suggest this interpretation. There is, however, but a distant relationship between these two genera, even if his idea that they are both Cestracions should prove correct. That *Campyloprion* is nearly related to *Helicoprion* will be readily admitted; indeed, there seems no obvious reason why the fossils referred to this genus may not have been parts of spirals similar to that of *Helicoprion*, and if so they might conveniently have remained in that genus.

With regard to *Edestus*, the form of each tooth-crown and base is so unlike those in *Helicoprion* that its generic distinction will not be disputed; but, at the same time, its near relationship to *Helicoprion* has not been questioned.

However anomalous the 'spiral saw' of *Helicoprion* may be, it seems most in accordance with our present knowledge to regard it as the enrolled dentition at or near the symphysis of an elasmobranch, possibly allied to Cestracions. That the forms referred to *Edestus* are of the same nature seems less probable; and, while admitting that this interpretation may prove correct for them also, it still seems to me that these straighter forms, with large anteriorly-projecting bases, are more likely to be dorsal defences.

BIBLIOGRAPHICAL LIST.

1. J. WARD. [On Marine Bands in the Coal-Measures of North Staffordshire.] *Geol. Mag.* vol. ii (1865) pp. 234 & 286.
2. E. HULL & A. H. GREEN. *Trans. Manch. Geol. Soc.* vol. iii (1862) p. 348.
3. E. HULL & J. W. SALTER. *Mem. Geol. Surv.* 'Geology of the Country around Oldham' 1864, p. 61.
4. E. HITCHCOCK. 'Account of the Discovery of the Fossil Jaw of an Extinct Family of Sharks from the Coal-Formation' *Proc. Amer. Assoc. Adv. Sci.* (Ninth Meeting, Providence, 1855) *Cambr.* 1856, p. 229.
5. JOSEPH LEIDY. 'Indications of Five Species, with Two New Genera, of Extinct Fishes' *Proc. Acad. Nat. Sci. Philad.* vol. vii, 1854-55 (1856) p. 414. Also *Journ. Acad. Nat. Sci. Philad.* ser. 2, vol. iii, 1856 (1858) p. 159 & pl. xv.
6. —. 'Remarks on certain Extinct Species of Fishes' *Proc. Acad. Nat. Sci. Philad.* vol. viii, 1856 (1857) p. 301.
7. R. OWEN. 'Palaeontology' 2nd ed. Edinburgh, 8vo (1861) pp. 123-24 & fig. 38.
8. J. S. NEWBERRY. *Geol. Surv. Illinois*, vol. ii (1866) p. 84 & pl. iv.
9. J. S. NEWBERRY & A. H. WORTHEN. *Ibid.* vol. iv (1870) p. 350 & pl. i, fig. 2.
10. H. TRAUTSCHOLD. 'Die Kalkbrüche von Mjatschkowa' *Nouv. Mém. Soc. Imp. Nat. Moscou*, vol. xiv (1879) p. 49 & pl. vi, fig. 8.
11. M. LOHEST. 'Recherches sur les Poissons des Terrains paléozoïques de Belgique' *Ann. Soc. Géol. Belg.* vol. xi (1883) p. 314.

12. H. TRAUTSCHOLD. 'Ueber *Edestus* und einige andere Fischreste des Moskauer Bergkalks' Bull. Soc. Imp. Nat. Moscou, vol. lviii, pt. ii, 1883 (1884) p. 160 & pl. v, figs. 1 & 2.
13. —. 'Ueber das Genus *Edestus*' *Ibid.* vol. lxi, pt. ii, 1885 (1886) p. 94.
14. H. WOODWARD. 'On a Remarkable Ichthyodorus from the Carboniferous Series, Gascoyne (Western Australia)' Geol. Mag. 1886, p. 1 & pl. i.
15. FANNY R. M. HITCHCOCK. 'On the Homologies of *Edestus*' Proc. Am. Assoc. Adv. Sci. (Thirty-sixth Meeting, New York, August 1887) Salem, 1888, p. 260. Also Amer. Nat. vol. xxi (1887) p. 847.
16. H. TRAUTSCHOLD. 'Ueber *Edestus protopirata*, Trd.' Zeitschr. Deutsch. Geol. Gesellsch. vol. xl (1888) p. 750.
17. J. S. NEWBERRY. 'On the Structure & Relations of *Edestus*, with a Description of a Gigantic New Species' Ann. N. Y. Acad. Sci. vol. iv, no. 4, 1888 (1889) p. 113 & pls. iv-vi. See also 'The Palæozoic Fishes of North America' Monogr. U.S. Geol. Surv. vol. xvi (1889) p. 217 & pls. xxxix-xl.
18. H. TRAUTSCHOLD. 'Ueber *Protopirata centrodon*, Trd.' Bull. Soc. Imp. Nat. Moscou, n. s. vol. iv, 1890 (1891) p. 317.
19. A. SMITH WOODWARD. Catal. Foss. Fishes Brit. Mus. pt. ii (1891) p. 151.
20. BASHFORD DEAN. 'On a New Species of *Edestus* (*E. Lecontei*) from Nevada' Trans. N. Y. Acad. Sci. vol. xvi (1898) p. 61 & pls. iv-v.
21. A. KARPINSKI. 'Ueber die Reste von Edestiden und die Neue Gattung *Helicoprion*' Verh. K.-Russ. Mineralog. Gesellsch. ser. 2, vol. xxxvi (1899) p. 361 & pls. i-iv; also Mém. Acad. Imp. Sci. St. Pétersb. ser. 8, vol. viii, no. 7 (1899) pp. 1-76 & pls. i-iv.
22. C. R. EASTMAN. [Review of Karpinski's Memoir.] Amer. Nat. vol. xxxiv (1900) p. 579.
23. —. 'On *Campodus variabilis*, N. & W.' Denver Meeting Amer. Assoc. Adv. Sci. n. s. vol. xiv (1901) p. 795.
24. —. 'On *Campyloprion*, a New Form of *Edestus*-like Dentition' Geol. Mag. 1902, p. 148 & pl. viii.
25. —. 'Some Carboniferous Cestraciant & Acanthodian Sharks' Bull. Mus. Comp. Zool. Harvard Coll. vol. xxxix, no. 3 (1902) p. 55 & pls. i-vii.
26. —. 'Carboniferous Fishes from the Central Western States' *Ibid.* vol. xxxix, no. 7 (1903) p. 184 & pl. i.
27. [Review of Karpinski's Memoir.] Bull. Soc. belge de Géol. vol. xiii (1903) for 1899, p. 205.
28. E. VAN DEN BROECK. [On the same.] *Ibid.* p. 215.
29. A. SMITH WOODWARD. 'Note sur l'*Helicoprion* et les *Édestidés*' *Ibid.* p. 230.
30. G. SIMOENS. 'Note sur *Helicoprion Bessonovi* (Karpinsky)' *Ibid.* p. 235.
31. C. VAN DE WIELE. 'Aperçu sur les Vestiges fossiles d'*Édestidés*, & le nouveau Genre *Helicoprion*' *Ibid.* p. 244.
32. H. YABE. 'On *Fusulina*-Limestone with *Helicoprion* in Japan' Journ. Geol. Soc. Tokyo, vol. x, no. 113, Jan. 20th (2563) 1903, p. 8.

EXPLANATION OF PLATE I.

Edestus triserratus, sp. nov.

From the Coal-Measures of Nettlebank (Staffordshire), preserved in the Museum of Practical Geology, Jernyn Street, London.

- Fig. 1. Side view. Natural size.
 2. Seen from above. Natural size.
 3. Side view of crown and part of base. Two and a half times the natural size.
 4. Crown and part of base seen from above. Two and a half times the natural size.
 5. Section of base at *h*. Two and a half times the natural size.
 6. View of broken end (*a*, *e*, *d*). Two and a half times the natural size.
 7. Denticles showing triserration. Six times the natural size.

DISCUSSION.

Dr. A. SMITH WOODWARD confirmed the Author's interpretation of the fossil exhibited, and remarked on the imperfection of our knowledge of the marine Upper Carboniferous fishes. The fragmentary character of the known remains of Edestidæ prevented the formation of any definite judgment as to their true nature. He regarded the fossils named *Edestus* and *Helicoprion* as the fused teeth of sharks, and alluded to the discovery of analogous whorls of teeth in the mouth of a Lower Devonian shark described by Dr. Traquair. He did not think that the more flattened rows of teeth needed a different interpretation from that of the more spiral whorls.

The AUTHOR, in reply, called attention to the use which the living 'sawfish' (*Pristis*) makes of its toothed rostrum, as indicating a possible function of the *Helicoprion*-spiral, if (as has been supposed) this was placed in front of the head.