

39. NOTES on the ANNELIDA TUBICOLA of the WENLOCK SHALES, from the WASHINGS of MR. GEORGE MAW, F.G.S. By GEORGE ROBERT VINE, Esq. Communicated by Prof. P. MARTIN DUNCAN, F.R.S., V.P.G.S. (Read June 7, 1882.)

[PLATE XV.]

THE bibliography of this very interesting group of animal remains is comparatively scanty if compared with the literature of some other groups. In his celebrated 'Petrefacten' (1820) Schlotheim founded the genus *Cornulites* for the inclusion of "certain Silurian fossils of somewhat doubtful affinities, but apparently most nearly allied to the tubicolar annelids"*. In the 'Silurian System,' published in 1839, species found in the Upper and Lower Silurian were identified with species described by Schlotheim; and since then authors have referred specimens to either *Tentaculites* or *Cornulites*. In 'Siluria,' and also in the 'Cambridge Catalogue,' Salter rectified somewhat the earlier errors by showing that some at least of the casts of specimens had been referred to as separate species. In his 'British Palæozoic Fossils' M'Coy redefines and limits the species of previous authors; but he adds little to our knowledge of the group generally. It is to Prof. Nicholson, whilst working amongst the American Palæozoic fauna, that we owe the most detailed account of Tubicolar Annelida, and that from material collected by himself. In working over the species which had previously been identified as *Tentaculites* he first saw the necessity of founding new genera for their reception. *Tentaculites* † was re-defined and limited, and Prof. Nicholson separated this group from ordinary Tubicolar Annelida; but I am not prepared to say that *Tentaculites* belongs to the Pteropoda. Following, however, the example set by Nicholson, I shall keep them separate, and deal with their structural peculiarities further on. The new genera founded by Nicholson are *Conchicolites* and *Ortonia*.

In Emmons's 'Manual of Geology' (1860), p. 108, a figure is given of *Cornulites arcuatus* as one of the fossils of the Clinton group of rocks possessing characters altogether different from *Cornulites*, and more like *Conchicolites* of Nicholson.

In the 'Catalogue of Cambrian and Silurian Fossils in the School of Mines' Mr. Newton furnishes us with a very poor list of British Silurian species as preserved in the museum in Jermyn Street:—

Caradoc	<i>Serpulites ceratoides</i> , Wyatt-Edgell, MS.
Upper Llandovery . .	<i>Cornulites serpularius</i> , Schlot.
Wenlock Shale	" <i>Serpulites curtus</i> ", Salter. " <i>Spirorbis</i> , sp.
Wenlock Limestone . .	<i>Cornulites serpularius</i> , Schlot. <i>Serpulites perversus</i> , M'Coy. <i>Spirorbis Lewisii</i> , Sowerby.

* Nicholson, Amer. Journ. Sci. 1872.

† Amer. Journ. Sci. & Arts, vol. iii, March 1873, p. 204.

Some of these species, with the addition of others, ranged into the Lower and Upper Ludlow, interesting particulars of which are given in the Presidential Address to the Geological Society in 1881 by Mr. Robert Etheridge, F.R.S.

I have been allowed to examine the typical specimens of *Ortonia* and *Conchicolites* which Prof. Nicholson has described in his various writings, and also the *Tentaculites minutus* of Mr. James's MS. I cannot but accept the two genera of Nicholson; but the specific characters of the American are not wholly applicable to British specimens. I am therefore compelled to describe them as new. In dealing with this group I have endeavoured to represent as fairly as possible the views of other authors; yet the very poor details furnished by them give small help in the way of original research. Nearly all the species are described superficially, and but little evidence of structure is afforded. Some of the figures in Murchison's 'Siluria' and in the 'Silurian System' are represented as having been polished, and so the peculiar characters of the walls of the tube are shown. The striation, too, of the smaller specimens of *Cornulites* can be examined, so as to obtain evidence of superficial structure; but as some of the examples* in the 'Siluria' are represented as being wholly attached to some foreign object, and as one of the characters of the genus *Cornulites* is that it is "attached by its smaller extremity to some foreign body," the species thus figured must of necessity be placed in another genus. I shall therefore arrange the described genera of Tubicolar Annelida of the Palæozoic formations as follows:—

I. CORNULITES, Schlotheim, Petrefacten, 1820.

Tube annulated, striated longitudinally, attached by some portion of its extremity to foreign bodies.

II. CONCHICOLITES, Nicholson, Geological Magazine, Feb. 1873.

Tube annulated, devoid of longitudinal striæ, slightly curved, attached by its smaller extremity to foreign bodies.

III. ORTONIA, Nicholson, Geological Magazine, October 1872.

Tube annulated; cellular or not along the surface opposite to its attached portion; slightly flexuous and attached along the whole of one side to some foreign body.

IV. SPIRORBIS, Lamarck.

Tube spirally twisted into an orbicular form, depressed, and adhering below. The spiral may be either right-handed (*dextral*) or left-handed (*sinistral*).

V. TENTACULITES, Schlotheim, Petrefacten, i. p. 377 (1820).

Tube annulated; devoid of longitudinal striæ or of cellular structure; conical, straight, tapering towards one extremity, and wholly unattached to any foreign body.

* Plate xvi. 'Siluria,' ed. 1859.

As I am not aware of the existence of any special terminology applicable to fossil Tubicolar Annelida, the following explanations of the few terms I shall use in my descriptions may be appreciated.

Tube: the whole of the shell of any one of the species.

Superior annulations: the ring-like divisions of the walls of the tube which show structure in section.

Inferior annulations: the intervening rings between the superior annulations in *Tentaculites* &c.

Lateral annulations: the prolonged annulations by means of which the tube is attached to foreign bodies.

Longitudinal striæ: markings having a structural character which cover the external surface of one genus of Tubicolar Annelida.

Intersected striæ: striæ, longitudinal or transverse, intersected by other striæ.

Subkingdom ANNULOSA.

Division BRANCHIATA.

Class II. ANNELIDA.

Order III. TUBICOLA.

Body protected by a calcareous or arenaceous tube. Branchiæ attached to or near the head.

Genus CORNULITES, Schloth.

In this genus the animal was solitary, inhabiting a shelly tube of carbonate of lime. The tube gradually tapering and slightly flexuous, attached by its *smaller extremity to some foreign body*. Walls of the tube very thick, composed of numerous imbricating conoidal rings, their widest edge next the slender base, subirregular in old specimens, more or less distorted or oblique in the young; external surface obscurely annulated, *finely striated longitudinally*; inner surface and casts scalariform, with two or three longitudinal furrows*. The only well-known species, *C. serpularius*, Schl.

Ref. Schloth. Petref. t. xxix. fig. 7; Sil. Syst. t. xxvi. figs. 5-8.

In the 'Cambridge Catalogue,' p. 128, Salter describes *C. serpularius*, Schl., as "a shelly tube, with cellular varices (knots) like *Tentaculites*, also grows in knots of 3, 4-8 young shells, separating afterwards."

Ref. Siluria, 2nd ed., pl. xvi. figs. 3-10.

Loc. and Formation. Typical *Cornulites*, Wenlock Limestone.

Dwarf specimens about an inch long, Upper Ludlow Rocks, Westmoreland. I cannot identify any of the species found in the Wenlock shales with either the typical *C. serpularius*, Schl., or the dwarf specimens referred to by McCoy in his Brit. Palæozoic Fossils.

1. CORNULITES SCALARIFORMIS, n. sp. (Pl. XV. figs. 1, 9 & 10.)

? *Tentaculites scalaris* of Sil. System and Siluria.

? *Tentaculites anglicus* of authors (part of Salter's sp.).

* Brit. Pal. Fossils, p. 63; and Nicholson, "On the Genera *Cornulites*," &c., Am. Journ. Sci. 1872, vol. iii. p. 203.

Tube hollow, attached by a portion of its proximal end to foreign bodies, the greater portion free. Very many fragments frequently found in the shales, varying from about a quarter to three quarters of an inch. Annulations superior, separated by depressed intervals, which give to the fragments a kind of scalariform aspect; strongly marked with "longitudinal" striæ, the width of which varies from $\frac{1}{100}$ to $\frac{1}{14}$ of an inch; the tube is again marked with transverse intersected striæ, varying from $\frac{1}{300}$ to $\frac{1}{250}$ of an inch in width. This cross-hatching gives to the tube a very peculiar character, and in all probability represents "cellular varices" of Salter and others.

Loc. Lower Wenlock Shales, no. 40; Upper Wenlock Shales, Tickwood beds, no. 41. Rare in both beds.

Remarks. It is quite possible that *C. scalariformis* may be upon a cursory examination identified either with *Tentaculites anglicus* or the smaller specimens of *Cornulites serpularius* of authors. The anomalous characters of both of these species cause me to approach them with a great amount of diffidence; and I am not certain that I shall improve the anomaly by the doubtful synonyms I have placed under the species described above. The following are my principal reasons for removing this species from the region of doubt. The peculiar annulations and striation of *C. scalariformis* are unique. I know of no other species with which I can compare it. In Salter's *T. anglicus* the external walls of the tube are longitudinally marked, and the transverse section shows by the small opening that the real diameter of the tube corresponds with the contraction of the vertebra-like section, which professes to be an enlargement of a fragment of the more perfect specimen. Otherwise than this there is no correspondence between the two types. Again, the structure of the walls of the tube when examined in section is altogether different in *C. scalariformis* from that of any typical *Tentaculites*. Salter's species is straight and unattached(?). This is sufficient in itself to show amongst which group it should be placed if it be a true *Tentaculites*; but I have satisfactory evidence that the species described above was not free.

Since writing the above I have been furnished with examples of the species from Gotland by Professor Lindström, of Stockholm. One fragment is attached to a valve of *Meristella* (*Whitfieldia*) *tumida*, and the proximal end is covered by a coral growth; the other specimens are unattached, but are identical with our own. The following are the microscopical characters of this species:—

Tube hollow, having a somewhat uniform diameter, which corresponds with the growth of the shell, widening gradually from a diminutive point to the distal extremity. Interior filled either with clay or calcite. Walls of the tube still retaining their normal character, varying in thickness from $\frac{1}{50}$ to $\frac{1}{20}$ of an inch. Superior annulations permeated by circular, oval, or angular cavities, a character which will be seen to more advantage in the drawing. In the transverse section of the species the longitudinal striæ appear

like spines, and these are developed apparently from an outer layer of the wall of the tube. Walls partaking of a laminar structure.

I have examined a great number of recent and fossil Annelida, but I cannot find in any of the calcareous tubes special characters corresponding with those of *C. scalariformis*. It is therefore to be hoped that this crude description will direct towards the *Cornulites* of the Silurian epoch the attention of critical palæontologists both at home and abroad.

Genus CONCHICOLITES, Nicholson.¹

Conchicolites, Am. Journ. of Science, March 1872. Type *C. gregarius*, Nich.

Conchicolites, Geol. Mag. Feb. 1873. Sp. *Conchicolites corrugatus*.*

This genus was founded by Nicholson, and referred to in full in the above papers and in his Palæontological and Natural History Manuals, for species which in all probability would be referred by authors to *Cornulites*, Schlot. The distinction between the two genera is something more than merely superficial; there are structural differences which widely separate the two groups, and in this paper I have given in my synopsis the leading and typical characters of the genera. I have not the material at hand to reexamine *Cornulites*, and I have only reproduced the textual outlines of previous authors. This is to be regretted; but I was unable to obtain specimens for a closer examination. I have, however, gone very carefully over the whole of the figures and text of both the 'Silurian System' and 'Siluria,' and also the details of Prof. M'Coy. In the separation of the present genus from *Cornulites* Prof. Nicholson has my warmest appreciation.

2. CONCHICOLITES NICHOLSONII, n. sp. (Pl. XV. fig. 2.)

Tube minute, calcareous, varying in length from 1 to 2 lines. Annulations very irregular, close or compacted together near the proximal end, rather more separated towards the distal end, the average number about ten to a line. Proximal end of the tube connected by lateral annulations to foreign objects, the remaining portion free.

Loc. Rather common in the Buildwas beds, no. 22; rare in the other washings. It is also present, but not abundant, in the Tickwood beds, nos. 25 and 42. Above these beds I have not detected it.

This beautiful and delicate Annelid I dedicate to Prof. Nicholson, on account of the very valuable labour which he has bestowed upon this genus. The species is a variable one, especially in the upper beds, but more in its manner of attachment than in the delicacy of its annulations. Beginning as a mere point, the tube assumes its normal character very early. For about $\frac{1}{30}$ of an inch the rings are very fine, and these are produced laterally, as the mode

* In this paper and description of figures the student must reverse the figures in text, &c.:—Figs. 2, 2a. *Ortonia minor*; figs. 3, 3a. *Conchicolites corrugatus*.

of attachment to foreign objects, either corals or shells. After the tube becomes fixed there is a gradual bending outwards, and sometimes for more than two thirds of its length it is free. Nearly all my specimens are separate in the shales, and I cannot therefore give any information as to whether the species was solitary or social.

3. *CONCHICOLITES GREGARIUS*, Nicholson.

Conchicolites gregarius, Nicholson, Amer. Journ. Sci. March 1872 : Geol. Mag. Feb. 1873 ; Manual of Palæontology, &c.

Var. *RUGOSUS*, n. var.

Tube calcareous, varying in length from 2 to 4 lines. Annulations irregular and rugose, sometimes entire or completely surrounding the tube, at other times forming imperfect rings only, about four in the space of a line. Diameter of the tube varying from three quarters of a line to a line ; mouth about half a line. Attached by some portion of the proximal end of the tube and by lateral annulations to foreign bodies.

Loc. Rather common in small fragments in the Buildwas beds, no. 22. Finely preserved in 38 and 40. Very rare in Coalbrookdale beds, no. 43. Present but not abundant in Tickwood beds, no. 25.

There is no possibility when care is exercised of confounding the present species with the former. The abundance of the two species in the same beds (no. 22 washing) affords a good opportunity of making a comparison between them. I have some specimens of *C. Nicholsonii* nearly the same length as the *C. rugosus*, and I can find that from the beginning and throughout the whole growth of the tube the characters of the two species are clearly defined. I have, however, preferred to give this type a varietal rather than a specific name. I cannot say positively that this is a form of Nicholson's species, but there seems to me a probability of its being so. When *C. gregarius* was described, the author had to depend on either a clustered mass attached to a shell of *Orthoceras Brongniarti* or upon casts. Neither of these show any structure ; but the cast figured by Nicholson * is so characteristic of *Conchicolites*, that I feel a pleasure in being able to remove any difficulty that obscures the description. Still there is a doubt, and to avoid any confusion I have fully described the variety.

There is a remarkable peculiarity about the superior annulations of *C. rugosus*. Whenever the tube is worn and the rotundity of the annulations destroyed there appears to be a number of lines only, and the space between these filled in with matrix. In normal character the rings are like an ordinary wedding-ring, round on the outside. If this rounded part be slightly rubbed small cavities appear, like pin-holes ; more rubbed, these are widened into lines ; deeper still, the apparently solid ring is divided into two lines, and

* Manual of Palæontology, vol. i. p. 312, fig. 182 (ed. 1879).

the matrix seen in rubbed specimens is the contents of the rounded hollow annular layers of growth of the tube. A very close correspondence therefore exists between this ancient type of Tubicolar Annelid and a similar one dredged from the Bay of Naples (50 fathoms), picked out from material sent to me by Mr. A. W. Waters, F.G.S. The recent species is not much longer than *C. Nicholsoni*, but it reveals the structure of the annular layers very satisfactorily; and one of my specimens is attached by its proximal end to a fragment of shell, but the point of attachment is covered by a small colony of *Cellepora*; the rest of the tube is free.

Genus ORTONIA, Nicholson.

Ortonia, Nicholson, Geol. Mag. 1872. Type *O. conica*, Nich., Silurian.

Ortonia, Nicholson, Geol. Mag. 1873. Sp. *O. minor*, Nich., Silurian.

Ortonia, Nicholson, Geol. Mag. 1874. Sp. *O. intermedia*, Nich., Devonian.

This genus was originally founded by Prof. Nicholson for the first of the three species named above. *Ortonia conica* is of a cellular character along the plane opposite to the plane of attachment. The other species are somewhat different from the original *O. conica*; and upon the publication of the characters and figures of *O. minor* Mr. John Young, of Glasgow, published in the 'Geological Magazine,' 1874, his description of *Ortonia carbonaria** of the Carboniferous formation of Scotland as nearly identical with *O. minor*. I can now add to our British Silurian fauna at least two types of this genus from the Wenlock Shales.

4. ORTONIA CONICA, Nicholson.

Ortonia conica, Nicholson (type), Geol. Mag. 1872.

Var. PSEUDO-PUNCTATA, n. var. (Plate XV. fig. 3.)

Tube solitary, slightly flexuous, adherent to stems of Crinoids; average length about two lines. Along the plane opposite to the attached side are apparently minute punctures, corresponding to the punctured surface of the type species. Walls of tube comparatively thick; mouth or orifice small. Attached by lateral annulations. In one specimen, two lines in length, there are sixteen rings, most of which are prolonged laterally.

Loc. Buildwas beds, 22 and 38.

This variety is better preserved in no. 22 than in no. 38. It is very rare, however, in the first-named washing, but rather more abundant in the last. It has, as will be seen by the description, many of the characters of the species; the most marked differences are the size and the punctations of the surface.

* I have a fine series of this type in my cabinet, which has been a very great help to me in the study of the Silurian species.

5. *ORTONIA SERPULIFORMIS*, n. sp. (Plate XV. fig. 4.)

Tube minute, attenuated-flexuous; adherent to species of corals; varying in length from one and half to two lines, but much more delicate in every respect than the last species. Tube adherent by its whole length; and in one specimen, in which the coral was too small, the distal part of the tube, gradually adapting itself to circumstances, turned over, and became adherent to the cross section of the coral.

Loc. Middle Wenlock Shales, Coalbrookdale beds, no. 43; Upper Wenlock Shales, Tickwood beds, no. 25.

Specimens of this species are rare, and I have not found it in any of the washings except the above, and only on corals. I cannot identify it with any of the species described by Prof. Nicholson; and as it closely resembles the attenuated proximal end of *Serpula vermicularis* of Brown's 'Conchologist's Text-Book,' pl. xix. fig. 14, I give it the above specific name. I do not know the recent species; and without having details of the species figured, I have no desire to make any comparison between the recent and the fossil type.

Genus *SPIRORBIS*, Lamarck.

6. *SPIRORBIS ARKONENSIS*, Nicholson.

New Devonian Fossils, Geol. Mag. 1874.

Tube minute, dextral, of two turns, the last turned upwards. Aperture circular. The diameter of the entire spiral is about one third of a line. Surface sparingly marked with annulations.

Loc. Buildwas beds, no. 22; Tickwood beds, no. 25. In this bed there is only a section of the tube preserved.

I have adopted Nicholson's name *S. arkonensis* for this most delicate Annelid. In my description I have accepted in part the diagnosis of the American Devonian fossil. There is a slight difference in the two forms, but so slight indeed that, unless one wanted to be very scrupulously exact, the two may pass unnoticed under one name. In measurement, but not in ornamentation, the two species are as nearly as can be the same.

Species belonging to this genus are exceedingly rare in the shale-washings. Only two out of the eleven localities have as yet yielded me specimens. One specimen from no. 22 is tolerably perfect and on a fragment of shell; the other is a section (base) of the tube on the tube of *Conchicolites Nicholsoni*. The specimen from no. 25 is on a fragment of coral; and this, too, is only a section.

The record of *Spirorbis* as a Silurian fossil is very meagre. No evidence is afforded by the collection in the School of Mines that it existed prior to the period of the Wenlock Shales. As the shales are derived from rocks of a previous age, its true home is not yet found. Very little additional detail is given in Mr. Robert Etheridge's famous address to the Geological Society. For specific details Sowerby's, so far as I am aware, is the only British species described. The following are the recorded Silurian species:—

Lower Wenlock Shales.

Buildwas beds, 22 *Spirorbis arkonensis*, Nich.
Coldwell Flags, Westmoreland *Spirorbis*, sp., Wyatt-Edgell.

Upper Wenlock Shales.

Tickwood beds, 25 *Spirorbis arkonensis*, Nich.

Wenlock Limestone.

School of Mines Cat. p. 101 *Spirorbis Lewisii*, Sow.

Upper Ludlow.

School of Mines Cat. p. 117 *Spirorbis*, n. sp., Murch.

Bone-bed.

School of Mines Cat. p. 129 *Spirorbis Lewisii*.

An important addition to my cabinet is a slide containing two or more species of *Spirorbis* and several specimens, given to me by Mr. Smith, and procured by him from the washing of shales from Lincoln-Hill Iron Bridge. It is beside my purpose to enter into details respecting these, because they do not belong to the shale-washings of Mr. Maw. I allude to their existence to prevent any misconception that may arise in the mind of the student when reading my remarks on the paucity of *Spirorbes* in the shale-washings.

GENUS TENTACULITES, Schlotheim.

Tentaculites, Restricted by Nicholson, American Journ. of Science, 1872, p. 204.

The genus *Tentaculites*, like many other Palæozoic genera, has had a very chequered palæontological history. By its author certain forms were regarded as the tentacular appendages of some of the Crinoids. Species figured in the 'Silurian System' were placed amongst the "incertæ sedis." In M'Coy's 'British Palæozoic Fossils' they were similarly placed; but one of the authors says, "I can see no reason for believing these bodies to be portions of Crinoids, as suggested by many authors, much less spines of *Lep-tæna*, as suggested by others; their small size, general form, and the appearance which large clusters of them often present on the surface of the beds, gives one the idea of their belonging to the Pteropoda. . . . Their being unattached, small size, and straight, regular form, separate them from the allied genus *Cornulites*"*. The same view of the zoological position of *Tentaculites* is taken by Prof. Nicholson in his various writings. Salter, however, believed these, as well as the species of *Cornulites*, to belong to the Tubicular Annelida; and Mr. Robert Etheridge†, seems to take a similar view in his address to the Geological Society.

Not knowing the special structure of the shell of the Pteropoda, to which the Palæozoic species may possibly be allied, I cannot

* Brit. Pal. Fossils, p. 63.

† Presidential Address, 1881.

institute the comparison that I should wish. If it be placed with *Theca* of Morris, a synonym of which is the *Creseis* of Forbes, then the nearest approach to the type is the Atlantic species *C. aciculata*, Rang; but in this type, as figured in Woodward's 'Manual of the Mollusca' (pl. 14, fig. 34), there is no appearance of annulations, and this is one of the chief peculiarities of *Tentaculites*.

The material for a complete study of this group, irrespective of its zoological affinities, is afforded by specimens in the shales. I do not think I am justified in placing upon record more than four species as prevalent in the washings; but their remains are so abundant, and so well preserved, that sections of the shells afford reliable evidence as to their special structure; and I must be pardoned if I step a little beyond the purely geological for the purpose of showing the microscopical evidence which the sections reveal. When the facts are formulated, a comparison can be made between the shells of *Tentaculites* and recent Pteropoda. I have been deceived so often in the mere external features of Palæozoic fossils when making a comparison with recent apparently allied types, that I feel certain a check upon hasty conclusions will be of the same value in researches of this kind to others as to me. There are other investigations outside of the pale of palæontological inquiries which must act as factors in the lines of research, as well as mere morphological details, and these must come in to help in the decision as to the zoological affinities of fossil types. I refer now especially to the masterly address of Dr. Sorby to the Geological Society in 1879.

In this address Dr. Sorby refers to the mineral constituents of certain shells, and he says that "this difference in the state of preservation of fossils, according as they were originally composed of calcite or of aragonite, appears to be so well established in all those cases in which we are able to ascertain the true mineral nature of closely allied living organisms, that I feel myself justified in concluding that certain doubtful fossil forms were originally calcite, because they are preserved like those in the same thin section known to have been so; whilst those known to have been aragonite have become quite crystalline and lost their original structure"*. Of Annelida Tubicola he says, "probably calcite, but they include many foreign fragments"†. Further on, again, he says "The shell has usually a more or less distinct laminar structure parallel to the surface of growth. The calcite is in the form of minute granules, often without any definite optical orientation"‡. As the *Tentaculites*, which will be referred to again, do retain their original structure, we may reasonably suppose that the shell at least was composed of calcite. I hope that these special mineralogical details will assist in guiding our judgment as to the proper zoological position of these unique Silurian fossils, as well as the more special and morphological details of authors.

* Dr. Sorby's Anniversary Address, Q. J. G. S. 1879, vol. xxxv. p. 68.

† Ibid. p. 60.

‡ Ibid. p. 63.

According to Prof. Nicholson, "The restricted genus *Tentaculites* may be defined as including small shells which have the form of STRAIGHT conical tubes, tapering towards one extremity to a pointed closed apex, and expanding towards the other to a rounded aperture. The shell is FREE; and its walls are thin, and are surrounded by numerous thickened rings or annulations." I have no evidence for the latter clause of Prof. Nicholson's restricted types; and I cannot therefore adopt it in this paper. His words are these:—"sometimes with intermediate striae over the whole or part of the length of the tube" *.

This part of the above is for the purpose of including the peculiar species of Salter; and to prevent any misconception, I reproduce the bibliography of this remarkable type.

7. *TENTACULITES ANGLICUS*, Salter, *Siluria*, 2nd ed. pl. i. fig. 3.

Straight, unattached, worm-tubes, resembling some horny Mediterranean species; and still more like the *Cornulites serpularius* of the Wenlock and Dudley Rocks (Cambr. Cat. p. 47).

T. scalaris, Schl., *Sil. Syst.* pl. xix. fig. 15.

T. scalaris, Schl. Llandovery species, internal cast of *T. anglicus* (Salter, *Siluria*, p. 221).

T. annulatus, Schl., *Sil.* pl. x. figs. 2 and 3 (ed. 1859).

T. anglicus, Salter (*Siluria*, 3rd ed. pl. i. fig. 3); *T. annulatus*, *Sil. Syst.* The *T. annulatus* is a Devonian form without the fine longitudinal striae (Salter, *Cambr. Catalogue*, p. 76).

T. annulatus, Salter, fig. 547; *Lyell, Elem. of Geology*, ed. 1871 (fig. 553, ed. 1878).

"Of the sixteen species of Annelida only two pass to the Lower and Upper Llandovery, *T. anglicus* and *Cornulites serpularius*. They range also to the Ludlow."—(Mr. Etheridge's *Presid. Address*, p. 108.)

I cannot identify the species in any of the Wenlock-Shale washings. If Salter's figures are to be relied upon, the nearest approach to the type is *Cornulites scalariformis* (see *ante*, pp. 379, 380); but this species is attached, and not free, as *T. anglicus* is said to be.

8. *TENTACULITES ORNATUS*, Sowerby.

Type, '*Siluria*,' fig. 11, plate xvi., especially the section magnified.

? *T. annulatus*, *His. Lethæa Suecica*, pl. xxxv. fig. 2 (1837).

Tube delicate, elongated, free, varying in length, but of unknown dimensions as regards the fragmentary condition of specimens found in the shales. Superior annulations placed at varying distances, about three to a line, spaces between marked by inferior annulations. Walls of tube thin, the hollow interior about two thirds the diameter of the tube, which, towards the distal extremity, is about half a line. The annulations at the proximal part of the tube, for about a line and a half from base, about 5 to a line.

Loc. Coalbrookdale beds, no. 43, rare; Tickwood beds, no. 25,

* *Geological Mag.* Oct. 1872. *Italics mine.*

also rare. Shales over the Wenlock Limestone, no. 46, rather more frequent.

In accepting this species as a Wenlock-shale type, I rely entirely upon the authority of fig. 11, pl. xvi. of 'Siluria,' 1859. In these figures we have a magnified portion given as a section. There are three superior annulations; and the lateral spine-like prolongations would reveal the typical structural characters of the genus if examined by the microscope, which will be referred to further on. A careful examination of another figure will show the intervening inferior annulations. In E. Emmons's 'Manual of Geology,' 2nd ed. New York, 1860, p. 113, fig. 102, a specimen of *T. ornatus* is figured, eight lines in length, and the diameter of the tube and number of annulations to the line are about the same as our own. This is from the Waterlime series, over the Niagara group; and it forms one of the series of the Helderberg, or upper division of the Silurian System. If Emmons's fossil is drawn from an American specimen, and the measurements can be relied upon, there is again a close correspondence between the two faunas, the British and American; for the figure is as like our own as it can possibly be. It is this type only that I accept as *T. ornatus*; my specimen of the Dudley-Limestone *Tentaculites*, named *T. ornatus* by collectors, is very different from this. *T. annulatus* of Hisinger's 'Lethæa Suecica,' from the Silurian Sandstone of Gotland, is also like some of the fragments.

9. TENTACULITES TENUIS?, Sowerby.

Type, fig. 12, pl. xvi. *Siluria*, ed. 1859.

A reference to the above figure will show that the annulations of this species are closer together than in the above; and in the text the author of 'Siluria' says, "*T. ornatus* abounds in the Dudley Limestone, whilst a small species, *T. tenuis*, occurs in the Upper Ludlow"*. I cannot verify the identifications of those authors who refer the delicate species found in the shales to this type; and I have no specimens of the Ludlow type to compare with my own. Seeing, therefore, that the specimens to be described below are found only in the shales over the Wenlock Limestone, I think it best to retain the species, and describe my own as a variety:—

Var. ATTENUATUS.

Tube very delicate and attenuated, of variable length, but specimens found in the shale-washings are from about one and a half to two lines long. Annulations superior, about twelve in the space of a line. Average diameter of the tube near the proximal end $\frac{1}{80}$, near the distal end $\frac{1}{48}$ of an inch. Walls of the tube thin, aperture round, and the length of the last or newest chamber nearly occupying the same space as three ordinary annulations.

Loc. Shales over the Wenlock Limestone, no. 46.

If this be *T. tenuis*, or a variety of the same, I shall be glad to fix

* Ed. 1859, p. 259.

the true type as above, for very special reasons. *Below* the Wenlock Limestone there are other *Tentaculites* equally delicate, but having characters in the annulations altogether different from the above; and unless these be separated, it is quite possible that collectors, at least, will confound the two types. This, to me, is of little importance; I seek to separate them on account of their significance in the palæontology of the shales.

10. *TENTACULITES WENLOCKIANUS*, n. sp. (Pl. XV. figs. 5, 6 & 11-13).

Tube delicate, elongated, varying in length from one to two and a half lines. Superior annulations in two series. The first series composed of rings alternately tumid and depressed, separated from each other by intervals of about a half of a line; the second series occupying the intervals between the first, and very rarely indenting the margins of the tube to any appreciable extent. The normal number is three, occasionally two, but rarely four. Very delicate inferior annulations fill in the remaining space; and these sometimes cover the superior annulations transversely. Average diameter of the tube near the proximal end about $\frac{1}{50}$, towards the distal end from $\frac{1}{20}$ to $\frac{1}{16}$ of an inch. Walls varying in thickness according to the tumid or depressed character of the tube; aperture circular.

Loc. The figures are given from specimens found in the lowest Buildwas beds, nos. 22, 36, & 38; Coalbrooke Dale beds, no. 43; Tickwood beds, no. 25. Shales above Wenlock Limestone, no. 46.

This species is found in fragments in most of the washings of the shales; and its range is from the lowest bed of the Buildwas series to the shales over the Wenlock Limestone. A reference to the figures will show the peculiarity of the annulations of both series; and this character is so constant that it matters not how small the fragment is, provided it is large enough to show at least two. The first series of rings gradually swell out to, and as gradually recede from, a central line. I have some fragments not more than $\frac{1}{50}$ of an inch in diameter; and the character is as constant in these as in those of $\frac{1}{20}$ or $\frac{1}{16}$ of an inch in diameter. This is a true Wenlock-shale type; and I think it may appropriately be named as above. There is, however, another type that has a range equally significant; but its characters are altogether different.

11. *TENTACULITES MULTIANNULATUS*, n. sp. (Pl. XV. fig. 7.)

Tube small, varying in length from a half to two and a half lines. Superior annulations closely compacted together, without the ordinary interspaces or inferior annulations seen in other species; average number about 20 in the space of a line. Walls very thin; aperture circular. Diameter of tube $\frac{1}{30}$ to $\frac{1}{16}$ of an inch.

Loc. Buildwas Beds, no. 22; Tickwood beds, 25. Shales over the Wenlock Limestone, no. 46.

I was for a very long time very diffident about placing this species with *Tentaculites*. My reasons for doing so now are these:—1. The tube is always found *free*, never attached; 2. The superior annulations,

though compacted together, are of the same character, structurally, as in other true *Tentaculitæ*; 3. The tube, though always filled either with calcite or clay, was evidently, in its natural state, hollow. My doubts are on account of the following facts elicited by a comparative study of the numerous specimens:—1. There are none of these Silurian specimens that can in any way be confounded with *Conchicolites* as limited in this paper; but to some extent the exterior annulations are very much like those of some specimens of that genus; structurally they are different. 2. Some of the Carboniferous *Ortoniæ* that are found free in the shales are also like the Silurian specimens described above as *Tentaculites*. 3. The one fact obtained by the study of specimens found in the shales over the Wenlock Limestone which compels me to place my doubt upon record is this: from these shales I have one fragment of *T. ornatus*, one line in length, half of which is true *T. ornatus*, the other half apparently *T. multiannullatus*. I cannot explain the fact; but I feel that it is incumbent on me to place it upon record.

Genus PSAMMOSIPHON*, gen. nov.

After completing my paper, as above, on the Annelida Tubicola, I was obliged to lay aside a mass of materials, chiefly from the Tickwood beds, on account of their many peculiarities. Amongst these were a group of Annelid remains that I was unable to refer to any existing genus, either recent or fossil. They were of an arenaceous texture, with very decided characters, both external and internal; and I was in doubt whether they should be referred to the Protozoa or placed with the Annelida. Since then I have examined an immense number of specimens, and I feel convinced that they may find a fitting resting-place with the latter group. Since, however, there is no genus known to me under which the species could be placed, I have been compelled to found a new one for their reception.

Generic Characters. Body irregularly disposed, crowded or tubular, composed of minute grains of sand; adherent to shells, stones, or corals, or free, but flattened at the base, showing evidence in the free specimens of former attachment.

The genus *Serpula* has a protecting tube composed of carbonate of lime; but the *Sabellarice* and *Terebellæ* have, generally speaking, arenaceous tubes; these genera, however, are of too decided a character to admit without violence the Palæozoic species. Every other genus referred to by Prof. Nicholson and Mr. Robert Etheridge, Jun., in their joint work 'On the Silurian Fossils of the Girvan District of Ayrshire'†, and by Prof. Nicholson in his 'Palæontology,' are likewise unsuitable for the admission of the species enumerated below.

12. PSAMMOSIPHON ELONGATUS, sp. nov.

Tube elongate, serial or biserial, varying in length from $\frac{4}{20}$ to $\frac{5}{20}$.

* This name is substituted for *Arenatubulites*. † Fasciculus iii. pp. 303–318.

of an inch, and with a transverse diameter of about $\frac{1}{20}$ of an inch. Composed of grains of shelly sand, with here and there minute grains somewhat larger than ordinary; slightly tapering towards the base. Orifice circular, with a rounded lip, thinning outwardly, and of rather larger dimensions than the normal size of the tube.

Loc. Tickwood beds, no. 25, rare. I am rather doubtful of species found in the Buildwas beds. Type specimen from no. 43, Coalbrookdale beds.

13. *PSAMMOSIPHON AMPLEXUS*, sp. nov. (Plate XV. fig. 8.)

Tubes irregularly clustered, embracing, forming sandy mounds, varying in size from one eighth to a quarter of an inch and more in breadth and height. Orifice circular, at the apex of small papillæ, which, in the most perfect state, stand out from the general mass of surrounding material, forming the distal part of the otherwise enclosed tube. Adherent by a flattened base to shells, stones, and, rarely, corals.

Loc. Tickwood beds, abundant in no. 42, less abundant in nos. 25 and 41.

Unlike the first species, which is to some extent solitary, this species is remarkable for its sociability. Beginning as a small, scarcely definable tube upon a fragment of stone or shell, it is soon followed by others, till a series are clustered together, so as to form groups of unknown dimensions. In the shale-washings the specimens are more frequently found free than attached. On the flattened or previously adherent side the exposed tubes are seen, varying in length from $\frac{1}{20}$ to $\frac{1}{50}$ of an inch.

The clayey sand, out of which the Annelid builds its tube, is of a pale yellow colour; and it is very rare to find specimens of a different tint. If broken up and examined under the microscope, it will be found that this sand is formed out of the débris of shells more frequently than out of other débris; and the whole is cemented together apparently by a chitinous secretion from the body. I cannot detect any particular structure in the tiny tubes; internally they are smooth and round and have a diameter rather less than the orifice of the tube when seen externally.

With our present incomplete knowledge of these fossil organic remains, I do not think I should be justified in an endeavour to establish more species of *Psammosiphon* than the two of which details are given above. Independently of my own labours, and entirely unknown to me until I saw the slides containing the specimens for naming, Mr. John Young, of the Hunterian Museum, Glasgow, discovered *P. amplexus* also in his Wenlock Shales*. I have also had, for examination and naming, the slides of Mr. J. Smith, of Kilwinning, procured from washings from the shale-heaps and railway-cuttings round Benthall Edge and Coalbrookdale†. Amongst these slides there were specimens of *Psammosiphon elongatus*

* From the Tickwood beds.

† A list of Entomostraca from these washings was given by Prof. Rupert Jones in Geol. Mag., Feb. 1881.

and *amplexus* from the railway-cutting opposite Swan Iron Bridge. Mr. Smith also procured specimens of *Tentaculites*, *Conchicolites* and *Cornulites* described in this paper.

There is, however, additional interest in the discovery of the arenaceous Annelid of the Silurian Shales. When sending his slide to me, Mr. John Young said :—"An almost identical form is found in the washings of the Hairmyres Shales from the Carboniferous formation of Scotland. At Hairmyres I have found it in somewhat larger fragments, and adherent to the stems of Crinoids and fronds of *Fenestella*—which shows that this Annelid was not a free form, but attached itself to other bodies. . . . The Carboniferous species I have not yet met with in any other locality than the one given"*.

This completes my list of Tubicular Annelida found in the shale-washings. Throughout the whole of the series I have not found any specimens which may undoubtedly be placed with the Annelida Polychæta of Dr. G. Jennings Hinde. I have found one specimen of a small jaw very much like the outline of the Much-Wenlock *Ænonites aspersus* of that author. It is serrated like that species, only with a less number of teeth; but the hook-like termination is also serrated with three teeth, and under the teeth of the longest part of the jaw there are circular places. The specimen is about a line and a half in length. It is from the shales over the Wenlock Limestone, no. 46.

In the figures of sections I have endeavoured more particularly to show the structural character of the tubes in the types of *Cornulites* and *Tentaculites*. These are so different that they must strike the eye at once; but my main object is to form a basis of future comparison for the more detailed study of the leading types of the Tubicular Annelida.

EXPLANATION OF PLATE XV.

- Fig. 1. *Cornulites scalariformis*, Vine, $\times 3$. 1 a. Portion of surface with longitudinal striae, further enlarged.
 2. *Conchicolites Nicholsoni*, Vine, $\times 10$.
 3. *Ortonia conica*, Nich., var. *pseudopunctata*, Vine, $\times 8$.
 4. — *serpuliformis*, Vine, $\times 10$.
 5, 6. *Tentaculites wenlockianus*, Vine, $\times 10$.
 7. — *multiannulatus*, Vine, $\times 10$.
 8. *Psammosiphon amplexus*, Vine, $\times 7$.
 9. *Cornulites scalariformis*, Vine; longitudinal section of tube, showing:—
 a, a, a, three of the superior annulations; b, b, walls of tube; c, c, calcite; d, matrix. $\times 15$.
 10. —, cross section of tube, $\times 50$. Letters as in preceding figure.
 11. *Tentaculites wenlockianus*, Vine; longitudinal section of tube, reversed.
 a, a, a, superior annulations; b, b, b, secondary superior annulations; c, c, walls of tube; d, matrix. $\times 50$.

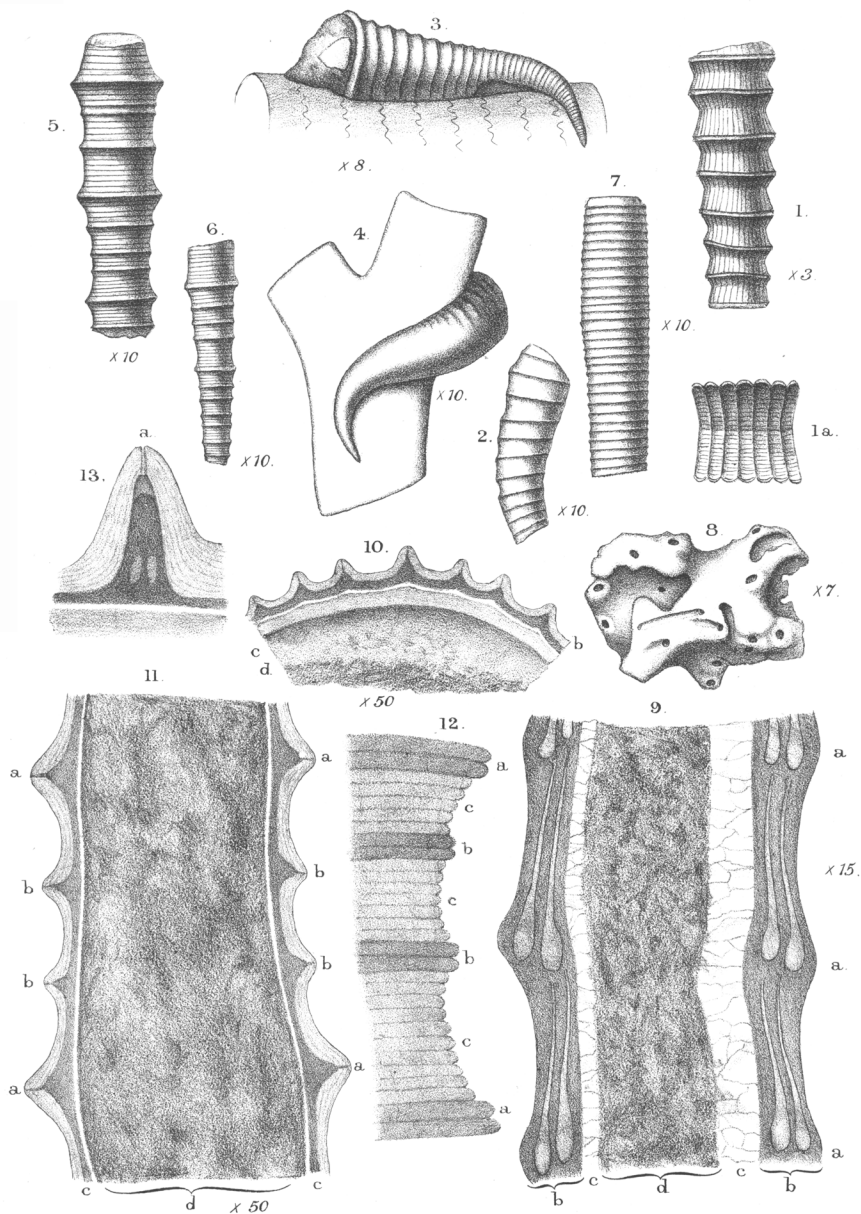
* Mr. J. Young, F.G.S. Letter dated Feb. 1882.

Fig. 12. *Tentaculites wenlockianus*; a nearly transparent section, showing the peculiar structure of the superior annulations seen in all true *Tentaculites*. *a, b, c*, as in fig. 11.

13. One of the superior annulations, $\times 110$.

DISCUSSION.

Dr. HINDE said he had seen the specimens, which were minute and fragmentary, but yet exhibited microscopic characters which might be relied on for specific description. He was not quite satisfied that some of the specimens placed in the genus *Psammosiphon* were really palæozoic. The specimen placed with a query under the genus *Enonites* appeared to be merely a fragment of a polyzoan, and not the jaw of an Annelid. He agreed with the author in placing *Tentaculites* among the Annelids; its close resemblance to *Conchicolites* and *Ortonia* showed its affinities to be with the Worms rather than with the pelagic Mollusca, notwithstanding that it was a *free* form.



C. Berjeau del et lith.

Mintern Bros. imp.

SILURIAN ANNELIDA