be needed to crush the chalk, a problem which Mr. O. Fisher might easily have faced before offering an hypothesis so remote from probability. But even if he had faced it we should be no nearer. There is no sign whatever of mere crushing in these chalk cliffs and great chalk masses. The chalk in them and the lines of flint in them are *quite intact, and so are the beds of consolidated gravel and finely* laminated sand which in many places are adherent to them. We should expect if the pressure had been sufficiently great to be efficient at all that it would have crushed these chalk beds into powder, and not curved them and twisted them in this way, or broken them off with sharp edges. The whole process seems to me utterly fantastic and impossible. I am not alone in thinking so. In this instance I quite agree with Mr. C. Reid when he says: "The Rev. O. Fisher's theory of the forcing up of the beds by irregular deposition of masses of material on their surface seems inadequate to the formation of contortions on so vast a scale. It is doubtful whether anything less than a mountain piled on the surface at Trimingham would be sufficient for the contortion of 200 feet of underlying strata." This is quite judicious, although it understates the difficulty, but in the face of such a statement what are we to say of Mr. Reid's own theory? After thus demolishing the Rev. O. Fisher's notion that the chalk dislocations were due to the differential pressure of superincumbent masses of strata as quite inadequate, he proceeds, without any attempt at a physical analysis of the conditions of the problem, to apply the very same kind of explanation himself, only substituting ice for beds of rock or sand or clay. Assuredly, nothing can well be more inconsequent, for it merely adds to the difficulties instead of diminishing them. Let us analyze his argument. The distinction in Mr. C. Reid's mind seems in some way to rest on a notion that while the postulated superincumbent rocks, sands, or clays here referred to would be *ex hypothesi* stationary, ice is in a measure mobile, and he says the explanation of the broken and contorted condition of the chalk is only possible on the hypothesis of "a lateral thrust, or of a sliding pressure from above."

(*To be continued.*)

## V.—Two New Species of *Eurypterus* from the Coal-Measures of Ilkeston, Derbyshire.

By Henry Woodward, LL.D., F.R.S., V.P.Z.S., F.G.S.

(PLATE XIII.)

BY the kindness of Mr. Henry A. Allen, F.G.S., of the Geological Survey of England, three examples of *Eurypterus*, in clay-ironstone nodules, showing impression and counterpart, together with a fragment of a fourth example, all from the Coal-measures to the north-west of Ilkeston, have been most obligingly lent me for description by their discoverer, Dr. L. Moysey, M.A., of St. Moritz, Ilkeston Road, Nottingham.

Remains of *Eurypterus* are extremely rare in the Coal-measures The earliest Carboniferous *Eurypterus* discovered and described was

*E. Scouleri* of Hibbert,[1] from a quarry at Kirkton, near Bathgate, West Lothian, in a fresh-water limestone containing much silica and associated with fronds of *Sphenopteris Hibberti.*[2] The first to be described in America was *Eurypterus* (*Anthraconectes*) *Mazonensis*, by Messrs. Meek & Worthen, from the Coal-measures of Grundy County, Illinois.[3] The next was in 1877, by Mr. Charles E. Hall, of the Geological Survey of Pennsylvania,[4] under the name of *E. Pennsylvanicus*, from the Lower Carboniferous rocks of Venango County, and another example from the Coal-measures of Cannelton, Pa., under the name of *Eurypterus* (*Dolichopterus*) *Mansfieldi*. These were noticed and refigured by Professor James Hall,[5] who added figures of Eurypteridæ from the Lower productive Coal-measures in Beaver Co. and the Lower Carboniferous Pithole Shale, Vernango Co. The additional species, noticed by Professor James Hall, were *E. Beecheri*, Hall (an Upper Devonian form from Warren, Pa.); *E. potens*, Hall, Carboniferous, Pa.; *E. stylus*, Hall, shale below Cannel Coal, Darlington, Pa.

A very interesting and well-preserved *Eurypterus*, named *E. scabrosus*, was discovered in 1886 in the Lower Carboniferous Series of Eskdale, Scotland, and figured and described in 1887.[6] Part of the body of another example, named *E. Wilsoni*, from the Coal-measures of Radstock, Somerset, was also figured and described by the writer.[7]

Other remains of *Eurypterus* have been referred to *E. Scouleri*[8] from the Carboniferous of Cape Breton. Another species, not determined, was noticed by Salter from the Carboniferous of Nova Scotia. A form doubtfully referred to *E. Scouleri* from the Upper Devonian of Kiltorcan, Ireland, and one named by Salter *E. pulicaris*,[9] from the Devonian of St. John's, New Brunswick; one from the Lower Devonian of Arbroath, *E. Brewsteri*[10]; one from the Passage Beds, Purton, Herefordshire, named *E. Brodiei*, H. Woodward, complete the Carboniferous and Devonian series.

In the Upper Silurian no fewer than 17 species of *Eurypterus* have been described, 10 being from Russia and North America, and 7 from Ludlow, Kendal, and Lanarkshire; the most perfectly preserved, however, are from North America, and from the Island of Oesel in the Baltic.[11] The dermal coverings of some of these

[1] Trans. Roy. Soc. Edin., vol. xiii (1836), pt. 1, p. 280, pl. xii.

[2] H. Woodward: Mon. Pal. Soc. Merostomata, 1872, pp. 133, 180, pls. xxv–xxvii and text-figs.

[3] See Amer. Journ. Science, vol. xlvi (1868), p. 21; afterwards more fully illustrated and described by the same authors in the Reports Geol. Surv. Illinois, vol. iii (1868), p. 544.

[4] Proc. Amer. Phil. Soc., vol. vii (1877), p. 621.

[5] Second Geol. Surv. Pennsylvania: Report of Progress P.P.P., 1884.

[6] H. Woodward: Geol. Mag., 1887, pp. 481–484, Pl. XIII.

[7] Geol. Mag., 1888, pp. 419–421, Woodcut.

[8] J. W. Salter: Quart. Journ. Geol. Soc., vol. xv (1859), p. 232, pl. x.

[9] J. W. Salter: Quart. Journ. Geol. Soc., vol. xviii (1863), p. 346; vol. xix, pp. 78–79.

[10] H. Woodward: Geol. Mag., Vol. I (1864), p. 200, Pl. X, Fig. 3.

[11] Fr. Schmidt, "Die Crustaceenfauna der Eurypteren-schichten von Rootziküll auf Oesel. Miscellanea silurica, iii": Mém. Acad. Imp. Sci. St. Pétersbourg (vii), vol. xxxi, No. 5, 1883.

Swedish specimens have lately been obtained in so perfect a state of preservation that they have been mounted on glass by Professor E. J. G. Holm, and a series so prepared are preserved in the Natural History Museum, Cromwell Road.[1]

Eurypterus Moyseyi,[2] H. Woodw., sp. nov. (Pl. XIII, Figs. 1, 2.)

Figs. 1 and 2 on our Plate XIII are drawn, slightly enlarged in each case, from one of the sides of two irregularly-shaped clay-ironstone nodules, which have been split open; Fig. 1 displaying also upon its inner surface, not only the Arthropod about to be described, but also the pinnule of a Neuropterid fern, attesting the near presence of land-conditions, as seen also on pl. iv, fig. 3, pl. vi, and pl. viii, fig. 2, of Professor Hall's figures of Eurypterids from the Carboniferous beds of Pennsylvania already referred to.

Our Fig. 1 shows clearly the semicircular fronted head-shield, with its truncated posterior border followed by seven rather narrow but transversely broad and arching post-cephalic segments. The head-shield carries the eyes, which are prominent and placed anteriorly and subcentrally on its upper surface; they are smooth (not facetted) and of the usual reniform outline. A raised semicircular ridge seems to unite them in front, but this is probably due to the squeezing upwards of the bases of two of the anterior pairs of endognaths; a detached portion of one of the palpi (*en.*) is seen on the left side of the head-shield, and two others on the right side.

Owing to the circumstance that the posterior portion of the cephalic shield has adhered to the counterpart of the nodule, the mouth organs on its under-side are more clearly exposed to view, and we see the oval metastoma, or post-oral plate (*m.*), occupying the centre of the space, having its attached hinder border rather below the posterior margin of the head, while its anterior, slightly notched, free extremity reaches to the centre of the head-shield. The broad basal joints of a pair of powerful ectognaths (*ec.*, *ec.*) flank the metastoma on either side; only a part of one of their swimming palps (*ec.*) is seen lying detached on the left side; perhaps the appendage labelled (*en.* 6) on the right side may be the other palpus, the distal spatulate extremity being in that case broken off, or concealed by the matrix. Endognath 5 (*en.* 5, Fig. 1) is a slender organ having only four of its original seven joints visible; the terminal joint being a simple and sharp spine.

The narrow median organ, or central appendage, of the opercular plate, the extremity of which is rounded, is seen in Fig. 1, *op.*, as a well-marked impression underlying the four anterior post-cephalic segments.

As in other species of this genus, the first segment following the head-shield is narrower than the rest; the three which follow are deeper, and increase gradually also in breadth; then follow three more, which become gradually narrower but do not diminish in

[1] E. J. G. Holm, "Ueber die Organisationen des *Eurypterus Fischeri*, Eichw.": Mém. Acad. Imp. Sci. St. Pétersbourg, Phys.-Math. Cl. (VIII), vol. viii, No. 2, 80 pp., 10 pls., 1898.

[2] Named in honour of the discoverer, Dr. L. Moysey, M.A., of St. Moritz, Ilkeston Road, Nottingham.

depth. These seven segments forming the thorax (*pereion* of Spence Bate) give to the body a somewhat globular or rounded contour. Those which follow (probably seven in number) were greatly reduced in breadth, but increased somewhat in depth, ending in all probability in a more or less long slender ensiform telson. Figs. 1 and 2 have only eight and nine segments respectively preserved, the remainder of the abdominal series, which extended into the matrix beyond the edge of the clay-ironstone nodule, being lost.

In *Eurypterus*, as in so many other Arthropods, each somite is clothed in a chitinous or calcareo-chitinous envelope, an upper part (or *tergum*) and a lower part (or *sternum*) giving rise at their junction to small recurved epimeral plates or pleuræ on the lateral margins of each segment. These tergites and sternites, in fossilisation, have been pressed together, and are often somewhat displaced along the margins of the segments, but the outer upper surface can always be readily detected by the presence of rows of minute squamate markings so characteristic of all the Merostomata (see Figs. 1 and 2).

Although the head-shield in Fig. 2 is less well preserved than that of Fig. 1, and the eyes are very indistinct, there are portions, nearly in place, of at least four jointed endognaths or palpiform organs (*en.* 1, 2, 3, 4), which served as mouth organs and also as locomotory appendages, the last and most posterior pair, which are always the largest, being modified to serve as powerful swimming feet. Probably *en.* 3 and 4 may represent this pair of swimming feet, one of which has been in that case displaced from the right side. The basal joints of this posterior pair occupy in Fig. 2 the same position as in Fig. 1, being placed one on either side of the oval metastoma. The greater part of the opercular plate (*op.*), situate immediately behind the head, is exposed to view by the removal of the tergites of the first and second body-segments, leaving the left side and the central appendage uncovered. Two of the series of narrow abdominal segments following the broad thorax are preserved in Fig. 2; also the pointed recurved pleuræ or epimera on the right side of the seven thoracic plates, which are well shown and quite in order.

In the figures given by Professor James Hall of the American *Eurypterus Mansfieldi* from below the Cannel Coal, Cannelton, Pa., the epimeral pieces on the margins of the body-segments are shown to be produced into strongly recurved spinous processes (see particularly op. cit., pl. iv, fig. 3, and pl. v, figs. 3 and 11). These spinous lateral processes also frequently occur detached, and I have seen such from our own Coal-measures, but I do not think they were so prominent on the segments of *Eurypterus Moyseyi*.

*Measurements.*—Fig. 1. Length of head-shield 21 cm., breadth at base 26 cm.; breadth between eyes at back 10 cm., length of eye 4 cm.; length of metastoma 10 cm., breadth 8 cm.; length of median appendage to opercular plate 12 cm., breadth 4 cm.; length from base of metastoma to base of 7th segment 21 cm.; greatest breadth of thorax 29 cm., average depth of thoracic segments 5½ cm.; breadth of first abdominal segment 15 cm., depth 7 cm.

Fig. 2. Length of head-shield 17 cm., breadth of base 23 cm.; length of seven thoracic segments 25 cm., greatest breadth 26 cm.; length of

median appendage to operculum 8 cm., breadth 4 cm.; breadth of 1st abdominal segment 14 cm., length 7 cm.; metastoma, length 10 cm., breadth 7 cm.

In the specimens of *Eurypterus*, figured and described by Professor James Hall from Pennsylvania, the body-segments, especially those of the abdomen, appear to be more narrow and elongated than these Derbyshire specimens indicate. *E. Moyseyi*, for instance, has a more globular or rotund thorax, and the ornamentation is less spinose and the squamæ are more minute.

The thoracic segments figured by me (see Geol. Mag., 1888, pp. 419–421) from the Coal-measures of Radstock, Somerset, evidently belonged (like the Scottish specimen named *E. scabrosus*) to a much larger form, at least twice, if not thrice, as large.

Eurypterus Derbiensis, sp. nov. (Pl. XIII, Fig. 3.)

This specimen is much smaller than the preceding examples and not very clearly preserved, being mixed with numerous detached and broken leaves of a fern; nevertheless, although at first doubtful, I am now inclined to regard it as being certainly distinct from *E. Moyseyi*, with which it was found associated.

The head-shield has the usual subquadrate form, rounded in front; the eyes, which are prominent and a little larger in proportion to its relative size, are placed somewhat closer together, and rather nearer the anterior margin than in *E. Moyseyi*. Two imperfect endognaths (*en.*) are seen on the right side of the head and one of the swimming feet (*ec.*) on the left side. The metastoma or post-oral plate (*m.*) is oval in form, its posterior border being hidden beneath the thoracic segments, which are squeezed together somewhat and have lost a part of their margins. There is a faint impression on the counterpart (not drawn) of a long median appendage belonging to the opercular plate seen beneath the thoracic sternites. What is very interesting is the presence of about six narrow but deep abdominal segments, having a crenulated ornamentation suggesting the presence of a row of marginal spines along the posterior border of each tergite. Similar plicæ are represented by James Hall in *E. Mansfieldi* (op. cit., pl. iv, fig. 3; pl. v, fig. 3; and pl. vi) from Pennsylvania.

*Dimensions.*—Total length of specimen 30 centimetres, greatest breadth of thorax 12 cm.; breadth of head 10 cm., length of head 6 cm.; length of thorax 9 cm.; length of abdomen 15 cm.; breadth of anterior segment 8 cm., length 4 cm.

This specimen (Fig. 3) differs slightly in the form of the head-shield, which is rather more quadrate than in Figs. 1 and 2; the body is more slender, and the plicæ (or spines?) along the posterior border of the abdominal segments are not seen on the posterior somites of Figs. 1 and 2. Possibly this might be considered as the male of the larger species, but the only other evidence is in the form of the imperfectly indicated median appendage of the opercular plate. Against this, however, is the fact that Figs. 1 and 2 differ probably quite as much from each other in the form of the opercular plate, and therefore Fig. 1 might equally well be deemed to be the male and Fig. 2 the female of the same species.

Under these circumstances, in order to avoid the inconvenience and suspense occasioned by a nameless fossil, I would suggest for Fig. 3 the specific designation of *Derbiensis* as serving also to mark geographical locality of this individual.

All the specimens are in the possession of the discoverer, Dr. L. Moysey, M.A., St. Moritz, Ilkeston Road, Nottingham, to whose courtesy I am indebted for permission to describe these very interesting Arthropods.

### EXPLANATION OF PLATE XIII.

FIGS. 1 and 2.—*Eurypterus Moyseyi*, H. Woodward, sp. nov. Enlarged $1\frac{1}{2}$ times nat. size.

FIG. 3.—*Eurypterus Derbiensis*, H. Woodward, sp. nov. Enlarged $2\frac{1}{2}$ times nat. size.

Clay-ironstone Coal-measures, all from a few feet below the "Top-Hard-Coal," $1\frac{1}{4}$ miles N.N.W. of Ilkeston, Derbyshire. Collection of Dr. L. Moysey, M.A.

*en.* endognath, one of the series of mouth organs (serving as maxillipeds) in Fig. 2 I have indicated *en.* 1, 2, 3, and 4.

*ec.* ectognath, indicate the basal joints (coxa) which form the chief organs of manducation; they form also powerful swimming organs (see figures in Professor Hall's work and in H. Woodward's Monograph on the Merostomata).

*m.* metastoma or post-oral plate, usually cordiform.

## REVIEWS.

### I.—THE ZONES OF NEOLITHIC TIMES.

STRANDLINIENS BELIGGENHED UNDER STENALDEREN I DET SYDÖSTLIGE NORGE. By W. C. BRÖGGER. With a German resumé, 11 plates, 2 maps, and 9 figures in the text. Norges Geologiske Undersögelse, No. 41. Kristiania, I commission hos H. Aschehoug & Co.; A. W. Bröggers Bogtrykkeri; 1905.

WE live in an age of zoning, but one may be pardoned for feeling surprise when one reads of the zoning of Neolithic deposits. The period embraced is geologically so short that one might on first thoughts have considered its subdivision into well-characterised zones as almost impossible. Yet this is what Professor Brögger has done, and it is of this that he gives us an account in the present volume. He has taken advantage of the rapid development of the skill and industry of man at this time, and has selected as his zone fossils the axe-heads of stone and flint which are found in the deposits of this age. He classifies them in certain types, according to their peculiarities of form, and each type he shows to be associated with a strand-line formed at some stage of recovery from the Littorina-Tapes depression. He is aided in this by the fact that the inhabitants of Norway during the early portion of the Northern Stone Age were fisher-folk, and lived mainly on the sea-shore. During its later stages they became more and more an agricultural and pastoral people, and their dwelling-places being no longer confined to the shore do not afford so exact a determination of its level. Yet even in this case it is possible to fix a limit for the height of the sea at that time.

A general account is given of the Littorina-Tapes depression and of